



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10

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OFFICE OF
WATER AND
WATERSHEDS

MEMORANDUM

SUBJECT: Results of CORMIX Modeling of the City of Sandpoint Wastewater Treatment Plant Discharge for Acute and Chronic Numeric Aquatic Life Water Quality Criteria

FROM: Brian Nickel, Environmental Engineer
NPDES Permits Unit

TO: June Bergquist, Idaho Department of Environmental Quality
Administrative Record for NPDES Permit Number ID00020842

1 Overview

Version 9.0GTD of the CORMIX Mixing Zone Expert System (CORMIX) was used to evaluate the mixing properties of toxic pollutants with acute and chronic numeric water quality criteria (e.g., ammonia, chlorine and mercury) found in the City of Sandpoint's Wastewater Treatment Plant discharge to the Pend Oreille River. The model scenarios described herein were adapted from earlier work by Mark Shumar of the Idaho Department of Environmental Quality.

2 Model Inputs

2.1 Channel Schematization

The river at the Sandpoint WWTP is very wide (9600ft), so the model was run as an unbounded channel with an average depth of 22 feet and a depth at discharge of 17 feet. A manning's "n" of 0.02 was used, consistent with the recommended value in the CORMIX user's manual for a smooth earth channel with no weeds (Table 4.3).

2.2 Ambient Current Velocity and Direction

The velocity used in the model was 0.2 ft/s, which was the low end of the ambient velocity measured by Bob Steed of the Idaho Department of Environmental Quality on 8/3/15. The direction at the surface was north 18° east (18° "clockwise" from true north). The direction at 80% depth was undetermined, so the direction measured at the surface was used for modeling. Under these conditions, the ambient velocity would push the plume toward the shore and then toward the spit at the north end of the "long bridge."

2.3 Diffuser Geometry

The diffuser is 50 meters long, with a midpoint 255 meters from shore. The diffuser axis is roughly perpendicular to the near shoreline. The diffuser has 41 ports of 3" diameter, which are oriented perpendicular to the diffuser axis (i.e., parallel to the near shoreline).

Using the map of the outfall provided with the application, I estimated the angle of the diffuser axis relative to the measured current (CORMIX calls this angle GAMMA) at 56°, and the angle of the ports relative to the current (SIGMA) at 146°. Refer to Figure 4.12 of the CORMIX User Manual (Page 55). Since the angle of the ports relative to the current is greater than 90°, the ambient velocity opposes the momentum of the discharge. CORMIX will run with this geometry *only if* the "Override Warnings" option is selected from the "Pre-Processing

Commented [JuneB1]: I added this to set it apart from the TP modeling recently updated by Mark. Otherwise people might get confused. I think it is also helpful here to explain why you did the toxics modeling (in response to USFWS comment right?).

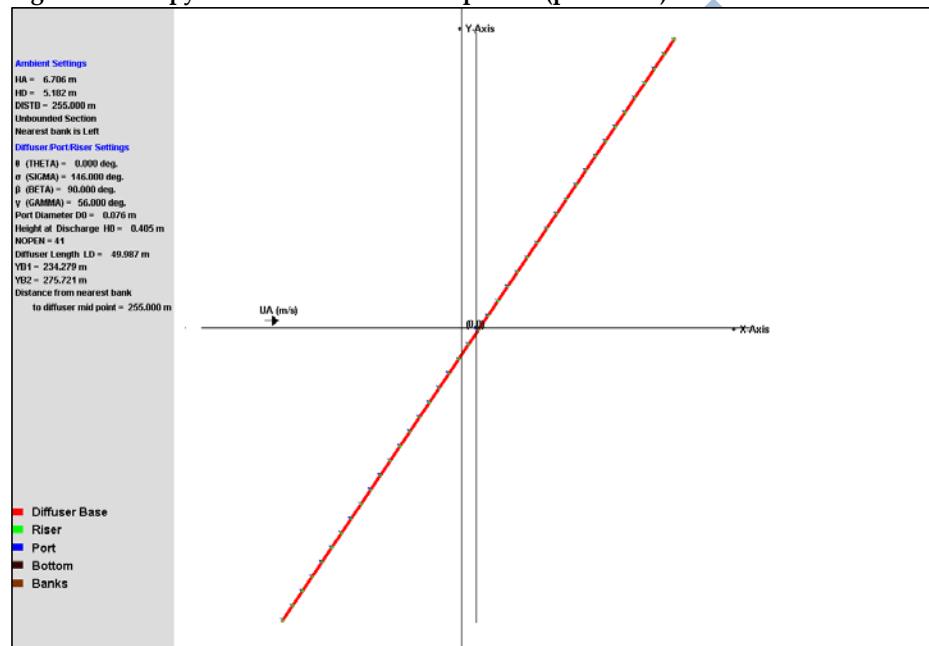
Commented [NB2R1]: I added the phrase "with acute and chronic numeric water quality criteria," and added an "e.g." in front of your list, because this actually applies to any pollutant with such criteria (including those for which we did not find reasonable potential).

I don't want to make too big a deal of ESA in this document because ultimately any permit condition needs to be based on the Clean Water Act and Idaho's water quality requirements.

Tools" menu. The CorSpy module in CORMIX was used to find the distance from shore to the near and far endpoints of the diffuser, based on the angles and the distance to the diffuser midpoint (255 meters).

This diffuser configuration is shown in Figure 1, below. Note that the ambient velocity (U_A) is parallel to the x-axis.

Figure 1: CorSpy view of diffuser from top town (plan view)



2.4 Ambient Temperature

Temperature data collected by DEQ in 2005 indicate a maximum of 0.8 °C of overall temperature stratification from the surface of the river to the bottom, with a median of zero. Both stratified and uniform ambient temperature scenarios were run, using actual temperature data for a particular date and time.

The uniform temperature run used an ambient temperature of 21.3 °C, which was observed on 8/13/05 between 8 pm and midnight. The stratified temperature run used a temperature of 21.3 °C at the surface and 20.5 °C at the bottom. These conditions were observed on 8/18/05 at 1:01 PM.

2.5 Effluent Temperature

The effluent temperature was set to 21°C, which is the maximum effluent temperature reported in August, rounded to the nearest whole degree.

2.6 Effluent Flow

The effluent flow was set equal to 5.0 mgd, which is the design flow of the POTW, consistent with federal regulations stating that, in the case of POTWs, permit effluent limitations, standards, or prohibitions shall be calculated based on design flow (40 CFR 122.45(b)(1)).

3 Mixing Zone Sizing

Dilution factors were determined for the acute and chronic mixing zones. Dilution factors are the ratios of ambient water to effluent at the edges of the mixing zones. The reciprocals of the dilution factors are the fractions of effluent in the water at the edges of the mixing zones.

The “size” of the mixing zone can also be expressed in terms of the effluent mixing with a certain fraction of the critical low river flows. Critical low flows vary by the type of criterion (acute or chronic aquatic life, or human health). For acute aquatic life criteria, the 1Q10 flow is used. For most chronic aquatic life criteria, the 7Q10 flow is used. Ammonia is an exception because the averaging period for the chronic ammonia criterion is 30 days, thus, the 30B3 is used.

The acute mixing zone was sized based so that both of the following conditions were met:

- Acute water quality are met after 15 minutes (900 seconds) of plume travel. This is one of the methods recommended in Sections 2.2.2 and 4.3.3 of the *Technical Support Document for Water Quality-based Toxics Control* (EPA 1991) to ensure that an acute mixing zone does not cause lethality to drifting or swimming organisms, if the discharge velocity is less than 3 meters per second. In this case, the discharge velocity is 1.17 meters per second.
- The acute mixing zone used no more than 25% of the 1-day, 10-year low flow (1Q10) of the Pend Oreille River (IDAPA 58.01.02.060.01.h.i(2)), which is 2,410 CFS. This provides a dilution ratio of 79:1.

The chronic mixing zone was sized so that both of the following conditions were met:

- Chronic water quality criteria are met at the point where the plume reaches the shore, which is about 380 meters from the point of discharge, in the direction of the ambient velocity (personal communication with Mark Shumar, Idaho Department of Environmental Quality, October 5, 2015).
- The chronic mixing zone used no more than 25% of the 7-day, 10-year low flow (7Q10) of the Pend Oreille River (IDAPA 58.01.02.060.01.h.i(2)), which is 3,880 CFS. This provides a dilution ratio of 126:1. Or, for ammonia only, the chronic mixing zone used no more than 25% of the 30B3 flow rate of the Pend Oreille River (IDAPA 58.01.02.060.01.h.i(2)), which is 8,090 CFS. This provides a dilution ratio of 262:1

4 Results

The dilution isolines shown in Figures 2 and 3 outline the modeled size and shape of the acute and chronic mixing zones (i.e., the portions of the effluent plume that can exceed acute and

chronic criteria) during two conditions: In Figure 2, when the temperature of the river water at the diffuser is uniform in temperature from top to bottom; and, in Figure 3, there is a difference of 0.8°C temperature from top to bottom.

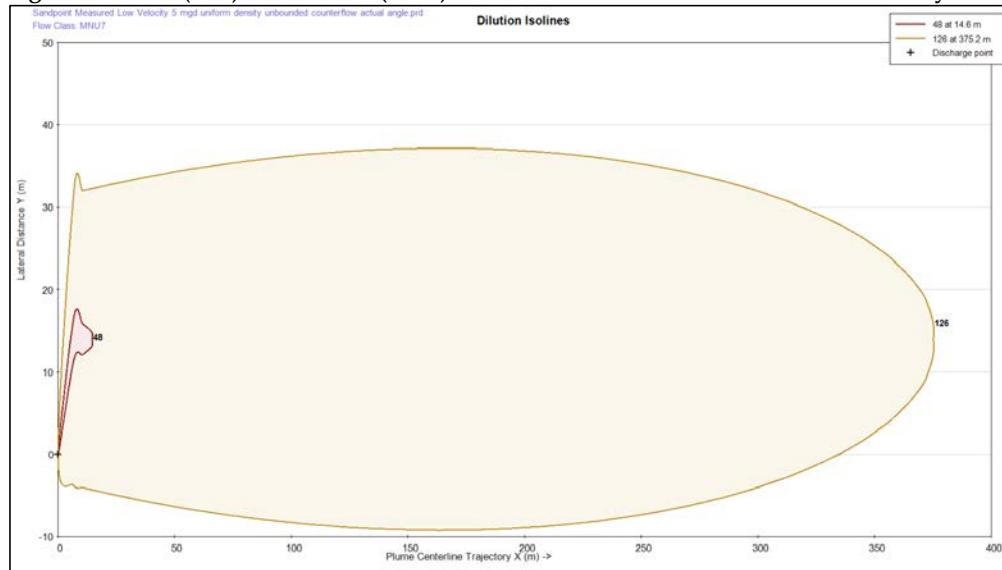
The difference in water density created by second scenario results in a significant positive effect on mixing; however, river temperature profile data show that a uniform temperature from top to bottom is common during summer months.

4.1 Uniform Ambient Density

- Chronic mixing zone: Dilution at 380m in the direction of the ambient velocity (shore): 128:1
 - This is equivalent to the effluent mixing with 25.3% of the 7Q10 river flow rate of 3,880 CFS or 12.1% of the 30B3 river flow rate of 8,090 CFS.
- Acute mixing zone: Dilution after 900 seconds (15 minutes) of plume travel : 48:1
 - This is equivalent to the effluent mixing with 15.1% of the 1Q10 river flow rate of 2,410 CFS.

The larger dilution isoline in Figure 2 is for the chronic mixing zone for parameters other than chlorine providing a dilution factor of 128:1 (i.e., 25% of the 7Q10). The chronic mixing zone for ammonia is not shown, but would extend 5 meters further downstream than the chronic mixing zone for other parameters. The smaller isoline is for the acute mixing zone, providing a dilution factor of 48:1.

Figure 2: Acute (48:1) and chronic (126:1) dilution isolines for uniform ambient density run



4.1.1 Parameter-Specific Results

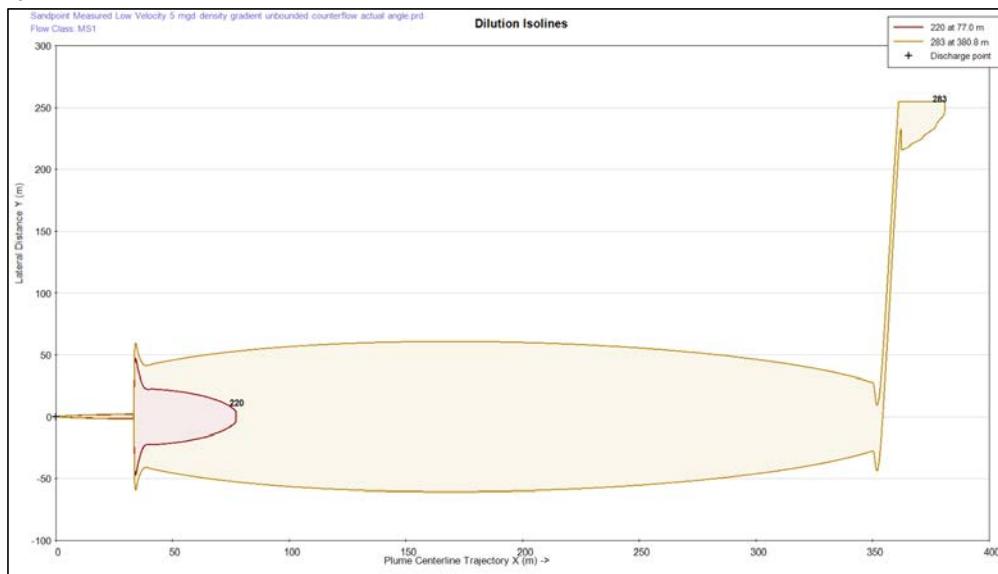
The model predicts poorer mixing with uniform ambient density than with stratified ambient density (see section 4.2, below), and river temperature profile data show that a uniform temperature from top to bottom is common during summer months. Thus, the uniform ambient density model was used for further investigation of the mixing zones for specific parameters, using the maximum projected effluent concentration, which is generally the maximum measured concentration multiplied by the reasonable potential multiplier. The results are as follows:

- Distance in the direction of the ambient velocity to meet ammonia criteria:
 - Acute: 6.7m
 - Plume Travel Time: 13 minutes (774 seconds)
 - Chronic: 440m
- Distance in the direction of the ambient velocity to meet chlorine criteria (using the maximum daily effluent limit from the prior permit):
 - Acute: 93m
 - Plume Travel Time: 36 minutes (2,155 seconds)
 - Chronic: 293m
- Distance in the direction of the ambient velocity distance to meet mercury criteria:
 - Acute: 0 meters (discharge meets the acute criterion at the end of pipe)
 - Chronic: 660m

4.2 Stratified Ambient Density

- Chronic mixing zone: Dilution at 380 m in the direction of the ambient velocity (shore): 283:1
- Acute mixing zone: Dilution after 900 seconds (15 minutes) of plume travel: 220:1

Figure 3: Acute (220:1) and chronic (283:1) dilution isolines for stratified ambient density run



5 Discussion and Recommendations

Since the uniform ambient temperature scenario predicts poorer mixing than the stratified ambient density scenario, and temperature data indicate that a uniform ambient temperature is commonly observed in the receiving water, the uniform ambient temperature scenario should be used for decision making.

The results of the uniform ambient temperature scenario indicate that:

- The dilution factor of **126:1** consistent with a mixing zone encompassing 25% of the 7Q10 flow rate of the Pend Oreille River is achieved 375 meters in the direction of the ambient velocity (see Figure 2), which is about 5 meters before the plume would reach the shore. Thus, for parameters with acute and chronic water quality criteria other than ammonia, a chronic mixing zone encompassing 25% of the 7Q10 and providing a dilution ratio of 126:1 is appropriate and supported by the CORMIX results.

Commented [JuneB3]: Is this applicable to phosphorus too?

Commented [NB4R3]: Not necessarily.

- A dilution factor of **128:1** is achieved 380 meters in the direction of the ambient velocity. This is less than the dilution factor consistent with a mixing zone encompassing 25% of the 30B3 river flow rate (262:1). Thus, for ammonia, the chronic mixing zone should be sized based on the CORMIX results rather than using 25% of the 30B3. As stated above, a dilution factor of 128:1 is equivalent to a mixing zone encompassing **12.1%** of the 30B3 river flow rate.
- A dilution factor of **48:1** is achieved after 15 minutes of plume travel. This is less than the dilution factor consistent with the 1Q10 river flow rate (79:1). Thus, the acute mixing zone should be based on the CORMIX results rather than using 25% of the 1Q10. As stated above, a dilution factor of 48:1 is equivalent to a mixing zone encompassing **15.1%** of the 1Q10 river flow rate.

6 References

Doneker, R.L. and G.H. Jirka. 2014. *CORMIX User Manual: A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters*. December 2007. Updated August 2014.

EPA. 1991. *Technical Support Document for Water Quality-based Toxics Control*. US Environmental Protection Agency, Office of Water, EPA/505/2-90-001. March 1991.
<http://www.epa.gov/npdes/pubs/owm0264.pdf>

Steed, Robert. 2015. Staff Report. Subject: Pend Oreille River Flow Measurements. August 3, 2015.

Commented [June85]: for which pollutants? The chronic MZ for ammonia is 12.1% but the acute is 15.1%? Somehow that doesn't sound right. The acute should be smaller than the chronic, right? I get a bit lost here.

Commented [NB6R5]: The acute mixing zone described in this memo is applicable to any pollutant that has an acute criterion in the WQS. All such criteria are 1-hour averages and the 15-minute travel time is consistent with the TSD's recommendation on limiting exposure to concentrations < acute criteria for more than 1 hour.

The only reason chronic ammonia is a special case is that it has a different averaging period (30 days) than everything else (4 days).

The chronic ammonia mixing zone is 12% of a much larger flow rate (the 30B3, which is 8,090 CFS) than the MZ for acute criteria (which uses the 1Q10, which is only 2,410 CFS).

Appendix A: CORMIX Prediction File for Uniform Ambient Density

CASE DESCRIPTION
Site name/label: Pend Oreille River - Sandpoint outfall
Design case: Sandpoint WWTP TP discharge to Pend Oreille River
FILE NAME: C:\...\rm density unbounded counterflow actual angle.prj
Time stamp: Wed Oct 21 14:08:52 2015

ENVIRONMENT PARAMETERS (metric units)

```

Unbounded section
HA      =       6.71 HD      =        5.18
UA      =       0.061 F      =        0.017 USTAR = 0.2781E-02
UW      =       3.576 UWSTAR=0.4081E-02
Uniform density environment
STRCND= U          RHOAM =   997.9279

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DIFFUSER DISCHARGE PARAMETERS (metric units)

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DIVERGENCE PLACEMENT (in centimeters)
Diffuser type: DIFTYPE= unidirectional_perpendicular
BANK = LEFT DISTB = 255.00 YB1 = 234.28 YB2 = 275.72
LD = 49.99 NOOPEN = 41 SPAC = 1.25
D0 = 0.076 A0 = 0.005 HO = 0.41 SUB0 = 4.78
D0INP = 0.076 CRO = 1.000
Nozzle/port arrangement: unidirectional_without_fanning
GAMMA = 56.00 THETA = 0.00 SIGMA = 146.00 BETA = 90.00
U0 = 1.172 Q0 = 0.219 =0.2191E+00
RHO0 = 997.9934 DRHO0 = -6549E-01 GP0 = -.6436E-03
C0 = 0.1000E+03 CUNITS = %
IPOLL = 1 KS = 0.0000E+00 KD = 0.0000E+00

```

```

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
q0      = 0.4382E-02   m0      = 0.5134E-02   j0      = -0.2820E-05   SIGNJ0=    -1.0
Associated 2-d length scales (meters)
lQ=B   =     0.004 1M   =       25.63  lm   =        1.38

```

```

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
Q0      = 0.2191E+00  M0      = 0.2567E+00  J0      = -.1410E-03
Associated 3-d length scales (meters)
LQ      =       0.07   LM      =       30.36   Lm      =       8.31   Lb      =       0.62
          Lmp     = 99999.00   Lbp     = 99999.00

```

NON-DIMENSIONAL PARAMETERS
 FRO = 754.93 FRD0 = 167.26 R = 19.22 PL = 140.00
 (solar) (post/poster)

```

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
Properties of riser group with 1 ports/nozzles each:
U0      =      1.172 D0      =      0.076 A0      =      0.005 THETA =      0.00
FR0     =    754.93 FRD0     =    167.26 R       =      19.22
(slot)           (riser group)

```

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
C0 = 0.1000E+03 CUNITS= %
NTOX = 0

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NSTD = 0
REGMZ = 0
XINT = 500.00 XMAX = 500.00

```

X-Y-Z COORDINATE SYSTEM:

ORIGIN is located at the bottom and the diffuser mid-point:
 255.00 m from the LEFT bank/shore.
 X-axis points downstream, Y-axis points to left, Z-axis points upward.

NSTEP = 100 display intervals per module

BEGIN MOD201: DIFFUSER DISCHARGE MODULE

Due to complex near-field motions: EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

Profile definitions:

BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
 BH = top-hat half-width, in horizontal plane normal to trajectory
 S = hydrodynamic centerline dilution
 C = centerline concentration (includes reaction effects, if any)
 Uc = Local centerline excess velocity (above ambient)
 TT = Cumulative travel time

| X | Y | Z | S | C | BV | BH | Uc | TT |
|------|------|------|-----|-----------|------|-------|-------|------------|
| 0.00 | 0.00 | 0.41 | 1.0 | 0.100E+03 | 0.00 | 24.99 | 1.222 | .00000E+00 |

END OF MOD201: DIFFUSER DISCHARGE MODULE

BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY MIXED over the entire layer depth (HS = 5.18m).
 Full mixing is achieved after a plume distance of about five layer depths from the diffuser.

Profile definitions:

BV = layer depth (vertically mixed)
 BH = top-hat half-width, in horizontal plane normal to trajectory
 S = hydrodynamic average (bulk) dilution
 C = average (bulk) concentration (includes reaction effects, if any)
 TT = Cumulative travel time

| X | Y | Z | S | C | BV | BH | TT |
|-------|------|------|------|-----------|------|-------|------------|
| -0.00 | 0.00 | 0.41 | 1.0 | 0.100E+03 | 0.00 | 24.99 | .00000E+00 |
| -0.21 | 0.14 | 0.43 | 5.3 | 0.189E+02 | 0.05 | 24.87 | .92053B+00 |
| -0.41 | 0.28 | 0.45 | 7.1 | 0.141E+02 | 0.10 | 24.74 | .23150E+01 |
| -0.62 | 0.42 | 0.47 | 8.5 | 0.118E+02 | 0.16 | 24.62 | .39637E+01 |
| -0.83 | 0.56 | 0.49 | 9.6 | 0.104E+02 | 0.21 | 24.51 | .57946E+01 |
| -1.04 | 0.70 | 0.51 | 10.6 | 0.942E+01 | 0.26 | 24.39 | .77685E+01 |
| -1.24 | 0.84 | 0.53 | 11.5 | 0.867E+01 | 0.31 | 24.28 | .98604E+01 |
| -1.45 | 0.98 | 0.55 | 12.4 | 0.808E+01 | 0.36 | 24.18 | .12053E+02 |
| -1.66 | 1.12 | 0.57 | 13.2 | 0.759E+01 | 0.41 | 24.07 | .14332E+02 |
| -1.86 | 1.26 | 0.60 | 13.9 | 0.719E+01 | 0.47 | 23.97 | .16688E+02 |
| -2.07 | 1.40 | 0.62 | 14.6 | 0.685E+01 | 0.52 | 23.88 | .19114E+02 |
| -2.28 | 1.54 | 0.64 | 15.3 | 0.655E+01 | 0.57 | 23.78 | .21601E+02 |
| -2.49 | 1.68 | 0.66 | 15.9 | 0.629E+01 | 0.62 | 23.69 | .24146E+02 |
| -2.69 | 1.82 | 0.68 | 16.5 | 0.606E+01 | 0.67 | 23.60 | .26743E+02 |
| -2.90 | 1.96 | 0.70 | 17.1 | 0.585E+01 | 0.73 | 23.51 | .29388E+02 |
| -3.11 | 2.10 | 0.72 | 17.7 | 0.566E+01 | 0.78 | 23.43 | .32077E+02 |
| -3.32 | 2.24 | 0.74 | 18.2 | 0.549E+01 | 0.83 | 23.34 | .34809E+02 |
| -3.52 | 2.38 | 0.76 | 18.7 | 0.534E+01 | 0.88 | 23.26 | .37579E+02 |
| -3.73 | 2.52 | 0.78 | 19.3 | 0.519E+01 | 0.93 | 23.19 | .40386E+02 |
| -3.94 | 2.66 | 0.81 | 19.8 | 0.506E+01 | 0.98 | 23.11 | .43228E+02 |
| -4.14 | 2.80 | 0.83 | 20.2 | 0.494E+01 | 1.04 | 23.04 | .46102E+02 |
| -4.35 | 2.94 | 0.85 | 20.7 | 0.483E+01 | 1.09 | 22.97 | .49008E+02 |
| -4.56 | 3.07 | 0.87 | 21.2 | 0.472E+01 | 1.14 | 22.90 | .51942E+02 |
| -4.77 | 3.21 | 0.89 | 21.6 | 0.462E+01 | 1.19 | 22.83 | .54905E+02 |

| | | | | | | | |
|--------|-------|------|------|-----------|------|-------|------------|
| -4.97 | 3.35 | 0.91 | 22.1 | 0.453E+01 | 1.24 | 22.76 | .57894E+02 |
| -5.18 | 3.49 | 0.93 | 22.5 | 0.444E+01 | 1.30 | 22.70 | .60909E+02 |
| -5.39 | 3.63 | 0.95 | 22.9 | 0.436E+01 | 1.35 | 22.63 | .63947E+02 |
| -5.59 | 3.77 | 0.97 | 23.4 | 0.428E+01 | 1.40 | 22.57 | .67010E+02 |
| -5.80 | 3.91 | 1.00 | 23.8 | 0.421E+01 | 1.45 | 22.51 | .70094E+02 |
| -6.01 | 4.05 | 1.02 | 24.2 | 0.414E+01 | 1.50 | 22.45 | .73200E+02 |
| -6.22 | 4.19 | 1.04 | 24.6 | 0.407E+01 | 1.55 | 22.39 | .76327E+02 |
| -6.42 | 4.33 | 1.06 | 25.0 | 0.401E+01 | 1.61 | 22.34 | .79474E+02 |
| -6.63 | 4.47 | 1.08 | 25.3 | 0.395E+01 | 1.66 | 22.28 | .82639E+02 |
| -6.84 | 4.61 | 1.10 | 25.7 | 0.389E+01 | 1.71 | 22.23 | .85824E+02 |
| -7.05 | 4.75 | 1.12 | 26.1 | 0.383E+01 | 1.76 | 22.18 | .89026E+02 |
| -7.25 | 4.89 | 1.14 | 26.5 | 0.378E+01 | 1.81 | 22.12 | .92245E+02 |
| -7.46 | 5.03 | 1.16 | 26.8 | 0.373E+01 | 1.87 | 22.07 | .95481E+02 |
| -7.67 | 5.17 | 1.19 | 27.2 | 0.368E+01 | 1.92 | 22.03 | .98733E+02 |
| -7.87 | 5.31 | 1.21 | 27.5 | 0.363E+01 | 1.97 | 21.98 | .10200E+03 |
| -8.08 | 5.45 | 1.23 | 27.9 | 0.359E+01 | 2.02 | 21.93 | .10528E+03 |
| -8.29 | 5.59 | 1.25 | 28.2 | 0.355E+01 | 2.07 | 21.89 | .10858E+03 |
| -8.50 | 5.73 | 1.27 | 28.5 | 0.350E+01 | 2.12 | 21.84 | .11189E+03 |
| -8.70 | 5.87 | 1.29 | 28.9 | 0.346E+01 | 2.18 | 21.80 | .11522E+03 |
| -8.91 | 6.01 | 1.31 | 29.2 | 0.342E+01 | 2.23 | 21.75 | .11856E+03 |
| -9.12 | 6.15 | 1.33 | 29.5 | 0.339E+01 | 2.28 | 21.71 | .12191E+03 |
| -9.32 | 6.29 | 1.35 | 29.9 | 0.335E+01 | 2.33 | 21.67 | .12528E+03 |
| -9.53 | 6.43 | 1.38 | 30.2 | 0.331E+01 | 2.38 | 21.63 | .12866E+03 |
| -9.74 | 6.57 | 1.40 | 30.5 | 0.328E+01 | 2.44 | 21.59 | .13205E+03 |
| -9.95 | 6.71 | 1.42 | 30.8 | 0.325E+01 | 2.49 | 21.55 | .13545E+03 |
| -10.15 | 6.85 | 1.44 | 31.1 | 0.321E+01 | 2.54 | 21.52 | .13885E+03 |
| -10.36 | 6.99 | 1.46 | 31.4 | 0.318E+01 | 2.59 | 21.48 | .14229E+03 |
| -10.57 | 7.13 | 1.48 | 31.7 | 0.315E+01 | 2.64 | 21.44 | .14572E+03 |
| -10.77 | 7.27 | 1.50 | 32.0 | 0.312E+01 | 2.69 | 21.41 | .14917E+03 |
| -10.98 | 7.41 | 1.52 | 32.3 | 0.309E+01 | 2.75 | 21.38 | .15263E+03 |
| -11.19 | 7.55 | 1.54 | 32.6 | 0.307E+01 | 2.80 | 21.34 | .15610E+03 |
| -11.40 | 7.69 | 1.56 | 32.9 | 0.304E+01 | 2.85 | 21.31 | .15957E+03 |
| -11.60 | 7.83 | 1.59 | 33.2 | 0.301E+01 | 2.90 | 21.28 | .16306E+03 |
| -11.81 | 7.97 | 1.61 | 33.5 | 0.299E+01 | 2.95 | 21.25 | .16656E+03 |
| -12.02 | 8.11 | 1.63 | 33.8 | 0.296E+01 | 3.01 | 21.22 | .17007E+03 |
| -12.23 | 8.25 | 1.65 | 34.0 | 0.294E+01 | 3.06 | 21.19 | .17358E+03 |
| -12.43 | 8.39 | 1.67 | 34.3 | 0.291E+01 | 3.11 | 21.17 | .17711E+03 |
| -12.64 | 8.53 | 1.69 | 34.6 | 0.289E+01 | 3.16 | 21.14 | .18064E+03 |
| -12.85 | 8.67 | 1.71 | 34.9 | 0.287E+01 | 3.21 | 21.11 | .18418E+03 |
| -13.05 | 8.81 | 1.73 | 35.1 | 0.285E+01 | 3.26 | 21.09 | .18773E+03 |
| -13.26 | 8.94 | 1.75 | 35.4 | 0.282E+01 | 3.32 | 21.06 | .19129E+03 |
| -13.47 | 9.08 | 1.78 | 35.7 | 0.280E+01 | 3.37 | 21.04 | .19486E+03 |
| -13.68 | 9.22 | 1.80 | 35.9 | 0.278E+01 | 3.42 | 21.02 | .19844E+03 |
| -13.88 | 9.36 | 1.82 | 36.2 | 0.276E+01 | 3.47 | 21.00 | .20202E+03 |
| -14.09 | 9.50 | 1.84 | 36.5 | 0.274E+01 | 3.52 | 20.98 | .20561E+03 |
| -14.30 | 9.64 | 1.86 | 36.7 | 0.272E+01 | 3.58 | 20.96 | .20921E+03 |
| -14.50 | 9.78 | 1.88 | 37.0 | 0.270E+01 | 3.63 | 20.94 | .21282E+03 |
| -14.71 | 9.92 | 1.90 | 37.2 | 0.268E+01 | 3.68 | 20.92 | .21643E+03 |
| -14.92 | 10.06 | 1.92 | 37.5 | 0.267E+01 | 3.73 | 20.90 | .22005E+03 |
| -15.13 | 10.20 | 1.94 | 37.8 | 0.265E+01 | 3.78 | 20.89 | .22368E+03 |
| -15.33 | 10.34 | 1.97 | 38.0 | 0.263E+01 | 3.83 | 20.87 | .22731E+03 |
| -15.54 | 10.48 | 1.99 | 38.3 | 0.261E+01 | 3.89 | 20.86 | .23096E+03 |
| -15.75 | 10.62 | 2.01 | 38.5 | 0.260E+01 | 3.94 | 20.84 | .23460E+03 |
| -15.95 | 10.76 | 2.03 | 38.8 | 0.258E+01 | 3.99 | 20.83 | .23826E+03 |
| -16.16 | 10.90 | 2.05 | 39.0 | 0.256E+01 | 4.04 | 20.82 | .24192E+03 |
| -16.37 | 11.04 | 2.07 | 39.2 | 0.255E+01 | 4.09 | 20.81 | .24559E+03 |
| -16.58 | 11.18 | 2.09 | 39.5 | 0.253E+01 | 4.15 | 20.80 | .24926E+03 |
| -16.78 | 11.32 | 2.11 | 39.7 | 0.252E+01 | 4.20 | 20.79 | .25294E+03 |
| -16.99 | 11.46 | 2.13 | 40.0 | 0.250E+01 | 4.25 | 20.78 | .25663E+03 |
| -17.20 | 11.60 | 2.16 | 40.2 | 0.249E+01 | 4.30 | 20.77 | .26032E+03 |
| -17.41 | 11.74 | 2.18 | 40.4 | 0.247E+01 | 4.35 | 20.76 | .26402E+03 |
| -17.61 | 11.88 | 2.20 | 40.7 | 0.246E+01 | 4.40 | 20.75 | .26773E+03 |
| -17.82 | 12.02 | 2.22 | 40.9 | 0.245E+01 | 4.46 | 20.75 | .27144E+03 |
| -18.03 | 12.16 | 2.24 | 41.1 | 0.243E+01 | 4.51 | 20.74 | .27515E+03 |
| -18.23 | 12.30 | 2.26 | 41.4 | 0.242E+01 | 4.56 | 20.73 | .27888E+03 |
| -18.44 | 12.44 | 2.28 | 41.6 | 0.240E+01 | 4.61 | 20.73 | .28260E+03 |
| -18.65 | 12.58 | 2.30 | 41.8 | 0.239E+01 | 4.66 | 20.72 | .28634E+03 |
| -18.86 | 12.72 | 2.32 | 42.0 | 0.238E+01 | 4.72 | 20.72 | .29007E+03 |

```

-19.06 12.86 2.35 42.3 0.237E+01 4.77 20.71 .29382E+03
-19.27 13.00 2.37 42.5 0.235E+01 4.82 20.71 .29757E+03
-19.48 13.14 2.39 42.7 0.234E+01 4.87 20.71 .30132E+03
-19.68 13.28 2.41 42.9 0.233E+01 4.92 20.70 .30508E+03
-19.89 13.42 2.43 43.2 0.232E+01 4.97 20.70 .30884E+03
-20.10 13.56 2.45 43.4 0.231E+01 5.03 20.70 .31261E+03
-20.31 13.70 2.47 43.6 0.229E+01 5.08 20.70 .31638E+03
-20.51 13.84 2.49 43.8 0.228E+01 5.13 20.70 .32016E+03
-20.72 13.98 2.51 44.0 0.227E+01 5.18 20.69 .32395E+03

```

Cumulative travel time = 323.9460 sec (0.09 hrs)

Plume centerline may exhibit slight discontinuities in transition
to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

BEGIN MOD251: DIFFUSER PLUME IN CO-FLOW

Phase 1: Vertically mixed, Phase 2: Re-stratified

Phase 1: The diffuser plume is VERTICALLY FULLY MIXED over the
entire layer depth.

This flow region is INSIGNIFICANT in spatial extent and will be by-passed.

Phase 2: The flow has RESTRATIFIED at the beginning of this zone.

This flow region is INSIGNIFICANT in spatial extent and will be by-passed.

END OF MOD251: DIFFUSER PLUME IN CO-FLOW

** End of NEAR-FIELD REGION (NFR) **

The initial plume WIDTH values in the next far-field module will be
CORRECTED by a factor 0.86 to conserve the mass flux in the far-field!

BEGIN MOD241: BUOYANT AMBIENT SPREADING

Profile definitions:

- BV = top-hat thickness, measured vertically
- BH = top-hat half-width, measured horizontally in y-direction
- ZU = upper plume boundary (Z-coordinate)
- ZL = lower plume boundary (Z-coordinate)
- S = hydrodynamic average (bulk) dilution
- C = average (bulk) concentration (includes reaction effects, if any)
- TT = Cumulative travel time

Plume Stage 1 (not bank attached):

| X | Y | Z | S | C | BV | BH | ZU | ZL | TT |
|--------|-------|------|------|-----------|------|-------|------|------|------------|
| -20.72 | 13.98 | 0.00 | 44.0 | 0.227E+01 | 5.18 | 15.26 | 5.18 | 0.00 | .32395E+03 |
| -16.80 | 13.98 | 0.00 | 44.4 | 0.225E+01 | 5.10 | 15.65 | 5.10 | 0.00 | .38826E+03 |
| -12.88 | 13.98 | 0.00 | 44.9 | 0.223E+01 | 5.03 | 16.03 | 5.03 | 0.00 | .45257E+03 |
| -8.96 | 13.98 | 0.00 | 45.3 | 0.221E+01 | 4.96 | 16.41 | 4.96 | 0.00 | .51688E+03 |
| -5.04 | 13.98 | 0.00 | 45.7 | 0.219E+01 | 4.90 | 16.78 | 4.90 | 0.00 | .58119E+03 |
| -1.12 | 13.98 | 0.00 | 46.2 | 0.217E+01 | 4.84 | 17.15 | 4.84 | 0.00 | .64549E+03 |
| 2.80 | 13.98 | 0.00 | 46.6 | 0.215E+01 | 4.78 | 17.51 | 4.78 | 0.00 | .70980E+03 |
| 6.72 | 13.98 | 0.00 | 47.0 | 0.213E+01 | 4.73 | 17.87 | 4.73 | 0.00 | .77411E+03 |
| 10.64 | 13.98 | 0.00 | 47.5 | 0.211E+01 | 4.68 | 18.23 | 4.68 | 0.00 | .83842E+03 |
| 14.56 | 13.98 | 0.00 | 47.9 | 0.209E+01 | 4.63 | 18.58 | 4.63 | 0.00 | .90273E+03 |
| 18.48 | 13.98 | 0.00 | 48.4 | 0.207E+01 | 4.59 | 18.93 | 4.59 | 0.00 | .96704E+03 |
| 22.40 | 13.98 | 0.00 | 48.8 | 0.205E+01 | 4.55 | 19.28 | 4.55 | 0.00 | .10314E+04 |
| 26.32 | 13.98 | 0.00 | 49.3 | 0.203E+01 | 4.51 | 19.62 | 4.51 | 0.00 | .10957E+04 |
| 30.24 | 13.98 | 0.00 | 49.8 | 0.201E+01 | 4.48 | 19.96 | 4.48 | 0.00 | .11600E+04 |
| 34.16 | 13.98 | 0.00 | 50.2 | 0.199E+01 | 4.45 | 20.29 | 4.45 | 0.00 | .12243E+04 |
| 38.08 | 13.98 | 0.00 | 50.7 | 0.197E+01 | 4.42 | 20.63 | 4.42 | 0.00 | .12886E+04 |
| 42.00 | 13.98 | 0.00 | 51.2 | 0.195E+01 | 4.39 | 20.96 | 4.39 | 0.00 | .13529E+04 |
| 45.92 | 13.98 | 0.00 | 51.7 | 0.194E+01 | 4.36 | 21.28 | 4.36 | 0.00 | .14172E+04 |
| 49.85 | 13.98 | 0.00 | 52.1 | 0.192E+01 | 4.34 | 21.61 | 4.34 | 0.00 | .14815E+04 |
| 53.77 | 13.98 | 0.00 | 52.6 | 0.190E+01 | 4.31 | 21.93 | 4.31 | 0.00 | .15458E+04 |

| | | | | | | | | | |
|--------|-------|------|-------|-----------|------|-------|------|------|------------|
| 57.69 | 13.98 | 0.00 | 53.1 | 0.188E+01 | 4.29 | 22.25 | 4.29 | 0.00 | .16101E+04 |
| 61.61 | 13.98 | 0.00 | 53.7 | 0.186E+01 | 4.27 | 22.57 | 4.27 | 0.00 | .16745E+04 |
| 65.53 | 13.98 | 0.00 | 54.2 | 0.185E+01 | 4.25 | 22.88 | 4.25 | 0.00 | .17388E+04 |
| 69.45 | 13.98 | 0.00 | 54.7 | 0.183E+01 | 4.24 | 23.19 | 4.24 | 0.00 | .18031E+04 |
| 73.37 | 13.98 | 0.00 | 55.2 | 0.181E+01 | 4.22 | 23.50 | 4.22 | 0.00 | .18674E+04 |
| 77.29 | 13.98 | 0.00 | 55.8 | 0.179E+01 | 4.21 | 23.81 | 4.21 | 0.00 | .19317E+04 |
| 81.21 | 13.98 | 0.00 | 56.3 | 0.178E+01 | 4.19 | 24.12 | 4.19 | 0.00 | .19960E+04 |
| 85.13 | 13.98 | 0.00 | 56.9 | 0.176E+01 | 4.18 | 24.42 | 4.18 | 0.00 | .20603E+04 |
| 89.05 | 13.98 | 0.00 | 57.4 | 0.174E+01 | 4.17 | 24.72 | 4.17 | 0.00 | .21246E+04 |
| 92.97 | 13.98 | 0.00 | 58.0 | 0.172E+01 | 4.16 | 25.02 | 4.16 | 0.00 | .21889E+04 |
| 96.89 | 13.98 | 0.00 | 58.6 | 0.171E+01 | 4.16 | 25.32 | 4.16 | 0.00 | .22532E+04 |
| 100.81 | 13.98 | 0.00 | 59.2 | 0.169E+01 | 4.15 | 25.62 | 4.15 | 0.00 | .23176E+04 |
| 104.73 | 13.98 | 0.00 | 59.7 | 0.167E+01 | 4.14 | 25.91 | 4.14 | 0.00 | .23819E+04 |
| 108.65 | 13.98 | 0.00 | 60.3 | 0.166E+01 | 4.14 | 26.20 | 4.14 | 0.00 | .24462E+04 |
| 112.57 | 13.98 | 0.00 | 61.0 | 0.164E+01 | 4.13 | 26.49 | 4.13 | 0.00 | .25105E+04 |
| 116.49 | 13.98 | 0.00 | 61.6 | 0.162E+01 | 4.13 | 26.78 | 4.13 | 0.00 | .25748E+04 |
| 120.41 | 13.98 | 0.00 | 62.2 | 0.161E+01 | 4.13 | 27.07 | 4.13 | 0.00 | .26391E+04 |
| 124.33 | 13.98 | 0.00 | 62.8 | 0.159E+01 | 4.13 | 27.35 | 4.13 | 0.00 | .27034E+04 |
| 128.25 | 13.98 | 0.00 | 63.5 | 0.158E+01 | 4.13 | 27.64 | 4.13 | 0.00 | .27677E+04 |
| 132.17 | 13.98 | 0.00 | 64.1 | 0.156E+01 | 4.13 | 27.92 | 4.13 | 0.00 | .28320E+04 |
| 136.09 | 13.98 | 0.00 | 64.8 | 0.154E+01 | 4.13 | 28.20 | 4.13 | 0.00 | .28963E+04 |
| 140.01 | 13.98 | 0.00 | 65.5 | 0.153E+01 | 4.13 | 28.48 | 4.13 | 0.00 | .29606E+04 |
| 143.93 | 13.98 | 0.00 | 66.2 | 0.151E+01 | 4.13 | 28.76 | 4.13 | 0.00 | .30250E+04 |
| 147.85 | 13.98 | 0.00 | 66.9 | 0.150E+01 | 4.14 | 29.04 | 4.14 | 0.00 | .30893E+04 |
| 151.77 | 13.98 | 0.00 | 67.6 | 0.148E+01 | 4.14 | 29.31 | 4.14 | 0.00 | .31536E+04 |
| 155.69 | 13.98 | 0.00 | 68.3 | 0.146E+01 | 4.15 | 29.58 | 4.15 | 0.00 | .32179E+04 |
| 159.61 | 13.98 | 0.00 | 69.0 | 0.145E+01 | 4.15 | 29.86 | 4.15 | 0.00 | .32822E+04 |
| 163.53 | 13.98 | 0.00 | 69.7 | 0.143E+01 | 4.16 | 30.13 | 4.16 | 0.00 | .33465E+04 |
| 167.46 | 13.98 | 0.00 | 70.5 | 0.142E+01 | 4.16 | 30.40 | 4.16 | 0.00 | .34108E+04 |
| 171.38 | 13.98 | 0.00 | 71.2 | 0.140E+01 | 4.17 | 30.67 | 4.17 | 0.00 | .34751E+04 |
| 175.30 | 13.98 | 0.00 | 72.0 | 0.139E+01 | 4.18 | 30.93 | 4.18 | 0.00 | .35394E+04 |
| 179.22 | 13.98 | 0.00 | 72.7 | 0.137E+01 | 4.19 | 31.20 | 4.19 | 0.00 | .36037E+04 |
| 183.14 | 13.98 | 0.00 | 73.5 | 0.136E+01 | 4.20 | 31.46 | 4.20 | 0.00 | .36681E+04 |
| 187.06 | 13.98 | 0.00 | 74.3 | 0.135E+01 | 4.21 | 31.73 | 4.21 | 0.00 | .37324E+04 |
| 190.98 | 13.98 | 0.00 | 75.1 | 0.133E+01 | 4.22 | 31.99 | 4.22 | 0.00 | .37967E+04 |
| 194.90 | 13.98 | 0.00 | 75.9 | 0.132E+01 | 4.23 | 32.25 | 4.23 | 0.00 | .38610E+04 |
| 198.82 | 13.98 | 0.00 | 76.8 | 0.130E+01 | 4.24 | 32.51 | 4.24 | 0.00 | .39253E+04 |
| 202.74 | 13.98 | 0.00 | 77.6 | 0.129E+01 | 4.25 | 32.77 | 4.25 | 0.00 | .39896E+04 |
| 206.66 | 13.98 | 0.00 | 78.4 | 0.128E+01 | 4.27 | 33.03 | 4.27 | 0.00 | .40539E+04 |
| 210.58 | 13.98 | 0.00 | 79.3 | 0.126E+01 | 4.28 | 33.29 | 4.28 | 0.00 | .41182E+04 |
| 214.50 | 13.98 | 0.00 | 80.1 | 0.125E+01 | 4.29 | 33.54 | 4.29 | 0.00 | .41825E+04 |
| 218.42 | 13.98 | 0.00 | 81.0 | 0.123E+01 | 4.31 | 33.80 | 4.31 | 0.00 | .42468E+04 |
| 222.34 | 13.98 | 0.00 | 81.9 | 0.122E+01 | 4.32 | 34.05 | 4.32 | 0.00 | .43112E+04 |
| 226.26 | 13.98 | 0.00 | 82.8 | 0.121E+01 | 4.34 | 34.31 | 4.34 | 0.00 | .43755E+04 |
| 230.18 | 13.98 | 0.00 | 83.7 | 0.119E+01 | 4.35 | 34.56 | 4.35 | 0.00 | .44398E+04 |
| 234.10 | 13.98 | 0.00 | 84.6 | 0.118E+01 | 4.37 | 34.81 | 4.37 | 0.00 | .45041E+04 |
| 238.02 | 13.98 | 0.00 | 85.6 | 0.117E+01 | 4.39 | 35.06 | 4.39 | 0.00 | .45684E+04 |
| 241.94 | 13.98 | 0.00 | 86.5 | 0.116E+01 | 4.40 | 35.31 | 4.40 | 0.00 | .46327E+04 |
| 245.86 | 13.98 | 0.00 | 87.5 | 0.114E+01 | 4.42 | 35.56 | 4.42 | 0.00 | .46970E+04 |
| 249.78 | 13.98 | 0.00 | 88.4 | 0.113E+01 | 4.44 | 35.80 | 4.44 | 0.00 | .47613E+04 |
| 253.70 | 13.98 | 0.00 | 89.4 | 0.112E+01 | 4.46 | 36.05 | 4.46 | 0.00 | .48256E+04 |
| 257.62 | 13.98 | 0.00 | 90.4 | 0.111E+01 | 4.47 | 36.30 | 4.47 | 0.00 | .48899E+04 |
| 261.54 | 13.98 | 0.00 | 91.4 | 0.109E+01 | 4.49 | 36.54 | 4.49 | 0.00 | .49543E+04 |
| 265.46 | 13.98 | 0.00 | 92.4 | 0.108E+01 | 4.51 | 36.78 | 4.51 | 0.00 | .50186E+04 |
| 269.38 | 13.98 | 0.00 | 93.4 | 0.107E+01 | 4.53 | 37.03 | 4.53 | 0.00 | .50829E+04 |
| 273.30 | 13.98 | 0.00 | 94.5 | 0.106E+01 | 4.55 | 37.27 | 4.55 | 0.00 | .51472E+04 |
| 277.22 | 13.98 | 0.00 | 95.5 | 0.105E+01 | 4.57 | 37.51 | 4.57 | 0.00 | .52115E+04 |
| 281.14 | 13.98 | 0.00 | 96.6 | 0.104E+01 | 4.60 | 37.75 | 4.60 | 0.00 | .52758E+04 |
| 285.07 | 13.98 | 0.00 | 97.6 | 0.102E+01 | 4.62 | 37.99 | 4.62 | 0.00 | .53401E+04 |
| 288.99 | 13.98 | 0.00 | 98.7 | 0.101E+01 | 4.64 | 38.23 | 4.64 | 0.00 | .54044E+04 |
| 292.91 | 13.98 | 0.00 | 99.8 | 0.100E+01 | 4.66 | 38.47 | 4.66 | 0.00 | .54687E+04 |
| 296.83 | 13.98 | 0.00 | 100.9 | 0.991E+00 | 4.68 | 38.71 | 4.68 | 0.00 | .55330E+04 |
| 300.75 | 13.98 | 0.00 | 102.0 | 0.980E+00 | 4.71 | 38.94 | 4.71 | 0.00 | .55974E+04 |
| 304.67 | 13.98 | 0.00 | 103.2 | 0.969E+00 | 4.73 | 39.18 | 4.73 | 0.00 | .56617E+04 |
| 308.59 | 13.98 | 0.00 | 104.3 | 0.959E+00 | 4.75 | 39.42 | 4.75 | 0.00 | .57260E+04 |
| 312.51 | 13.98 | 0.00 | 105.4 | 0.948E+00 | 4.78 | 39.65 | 4.78 | 0.00 | .57903E+04 |
| 316.43 | 13.98 | 0.00 | 106.6 | 0.938E+00 | 4.80 | 39.88 | 4.80 | 0.00 | .58546E+04 |
| 320.35 | 13.98 | 0.00 | 107.8 | 0.928E+00 | 4.83 | 40.12 | 4.83 | 0.00 | .59189E+04 |

| | | | | | | | | | |
|--------|-------|------|-------|-----------|------|-------|------|------|------------|
| 324.27 | 13.98 | 0.00 | 109.0 | 0.918E+00 | 4.85 | 40.35 | 4.85 | 0.00 | .59832E+04 |
| 328.19 | 13.98 | 0.00 | 110.2 | 0.908E+00 | 4.88 | 40.58 | 4.88 | 0.00 | .60475E+04 |
| 332.11 | 13.98 | 0.00 | 111.4 | 0.898E+00 | 4.90 | 40.81 | 4.90 | 0.00 | .61118E+04 |
| 336.03 | 13.98 | 0.00 | 112.6 | 0.888E+00 | 4.93 | 41.04 | 4.93 | 0.00 | .61761E+04 |
| 339.95 | 13.98 | 0.00 | 113.9 | 0.878E+00 | 4.96 | 41.27 | 4.96 | 0.00 | .62405E+04 |
| 343.87 | 13.98 | 0.00 | 115.1 | 0.869E+00 | 4.98 | 41.50 | 4.98 | 0.00 | .63048E+04 |
| 347.79 | 13.98 | 0.00 | 116.4 | 0.859E+00 | 5.01 | 41.73 | 5.01 | 0.00 | .63691E+04 |
| 351.71 | 13.98 | 0.00 | 117.7 | 0.850E+00 | 5.04 | 41.96 | 5.04 | 0.00 | .64334E+04 |
| 355.63 | 13.98 | 0.00 | 118.9 | 0.841E+00 | 5.07 | 42.19 | 5.07 | 0.00 | .64977E+04 |
| 359.55 | 13.98 | 0.00 | 120.3 | 0.832E+00 | 5.09 | 42.42 | 5.09 | 0.00 | .65620E+04 |
| 363.47 | 13.98 | 0.00 | 121.6 | 0.823E+00 | 5.12 | 42.64 | 5.12 | 0.00 | .66263E+04 |
| 367.39 | 13.98 | 0.00 | 122.9 | 0.814E+00 | 5.15 | 42.87 | 5.15 | 0.00 | .66906E+04 |
| 371.31 | 13.98 | 0.00 | 124.2 | 0.805E+00 | 5.18 | 43.09 | 5.18 | 0.00 | .67549E+04 |

Cumulative travel time = 6754.9312 sec (1.88 hrs)

END OF MOD241: BUOYANT AMBIENT SPREADING

Due to the attachment or proximity of the plume to the bottom, the bottom coordinate for the FAR-FIELD differs from the ambient depth, ZFB = 0 m.
In a subsequent analysis set "depth at discharge" equal to "ambient depth".

BEGIN MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

Vertical diffusivity (initial value) = 0.464E-02 m^2/s
Horizontal diffusivity (initial value) = 0.227E+00 m^2/s

Profile definitions:
 BV = Gaussian s.d.*sqrt(pi/2) (46%) thickness, measured vertically
 = or equal to layer depth, if fully mixed
 BH = Gaussian s.d.*sqrt(pi/2) (46%) half-width,
 measured horizontally in Y-direction
 ZU = upper plume boundary (Z-coordinate)
 ZL = lower plume boundary (Z-coordinate)
 S = hydrodynamic centerline dilution
 C = centerline concentration (includes reaction effects, if any)
 TT = Cumulative travel time

Plume Stage 1 (not bank attached):

| X | Y | Z | S | C | BV | BH | ZU | ZL | TT |
|--------|-------|------|-------|-----------|------|-------|------|------|------------|
| 371.31 | 13.98 | 0.00 | 124.2 | 0.805E+00 | 5.18 | 43.09 | 5.18 | 0.00 | .67549E+04 |

Plume interacts with SURFACE.

The passive diffusion plume becomes VERTICALLY FULLY MIXED within this prediction interval.

| | | | | | | | | | |
|--------|-------|------|-------|-----------|------|-------|------|------|------------|
| 372.60 | 13.98 | 0.00 | 124.8 | 0.801E+00 | 5.18 | 43.27 | 5.18 | 0.00 | .67760E+04 |
| 373.89 | 13.98 | 0.00 | 125.3 | 0.798E+00 | 5.18 | 43.44 | 5.18 | 0.00 | .67971E+04 |
| 375.17 | 13.98 | 0.00 | 125.8 | 0.795E+00 | 5.18 | 43.62 | 5.18 | 0.00 | .68183E+04 |
| 376.46 | 13.98 | 0.00 | 126.3 | 0.792E+00 | 5.18 | 43.79 | 5.18 | 0.00 | .68394E+04 |
| 377.75 | 13.98 | 0.00 | 126.8 | 0.789E+00 | 5.18 | 43.97 | 5.18 | 0.00 | .68605E+04 |
| 379.03 | 13.98 | 0.00 | 127.3 | 0.786E+00 | 5.18 | 44.14 | 5.18 | 0.00 | .68816E+04 |
| 380.32 | 13.98 | 0.00 | 127.8 | 0.782E+00 | 5.18 | 44.32 | 5.18 | 0.00 | .69027E+04 |
| 381.61 | 13.98 | 0.00 | 128.3 | 0.779E+00 | 5.18 | 44.49 | 5.18 | 0.00 | .69238E+04 |
| 382.89 | 13.98 | 0.00 | 128.8 | 0.776E+00 | 5.18 | 44.67 | 5.18 | 0.00 | .69449E+04 |
| 384.18 | 13.98 | 0.00 | 129.3 | 0.773E+00 | 5.18 | 44.85 | 5.18 | 0.00 | .69660E+04 |
| 385.47 | 13.98 | 0.00 | 129.8 | 0.770E+00 | 5.18 | 45.02 | 5.18 | 0.00 | .69871E+04 |
| 386.75 | 13.98 | 0.00 | 130.4 | 0.767E+00 | 5.18 | 45.20 | 5.18 | 0.00 | .70082E+04 |
| 388.04 | 13.98 | 0.00 | 130.9 | 0.764E+00 | 5.18 | 45.38 | 5.18 | 0.00 | .70294E+04 |
| 389.33 | 13.98 | 0.00 | 131.4 | 0.761E+00 | 5.18 | 45.56 | 5.18 | 0.00 | .70505E+04 |
| 390.62 | 13.98 | 0.00 | 131.9 | 0.758E+00 | 5.18 | 45.73 | 5.18 | 0.00 | .70716E+04 |
| 391.90 | 13.98 | 0.00 | 132.4 | 0.755E+00 | 5.18 | 45.91 | 5.18 | 0.00 | .70927E+04 |
| 393.19 | 13.98 | 0.00 | 132.9 | 0.752E+00 | 5.18 | 46.09 | 5.18 | 0.00 | .71138E+04 |
| 394.48 | 13.98 | 0.00 | 133.4 | 0.749E+00 | 5.18 | 46.27 | 5.18 | 0.00 | .71349E+04 |
| 395.76 | 13.98 | 0.00 | 133.9 | 0.747E+00 | 5.18 | 46.45 | 5.18 | 0.00 | .71560E+04 |
| 397.05 | 13.98 | 0.00 | 134.5 | 0.744E+00 | 5.18 | 46.63 | 5.18 | 0.00 | .71771E+04 |
| 398.34 | 13.98 | 0.00 | 135.0 | 0.741E+00 | 5.18 | 46.81 | 5.18 | 0.00 | .71982E+04 |
| 399.62 | 13.98 | 0.00 | 135.5 | 0.738E+00 | 5.18 | 46.99 | 5.18 | 0.00 | .72193E+04 |
| 400.91 | 13.98 | 0.00 | 136.0 | 0.735E+00 | 5.18 | 47.16 | 5.18 | 0.00 | .72405E+04 |
| 402.20 | 13.98 | 0.00 | 136.5 | 0.732E+00 | 5.18 | 47.34 | 5.18 | 0.00 | .72616E+04 |
| 403.48 | 13.98 | 0.00 | 137.1 | 0.730E+00 | 5.18 | 47.52 | 5.18 | 0.00 | .72827E+04 |

| | | | | | | | | | |
|--------|-------|------|-------|-----------|------|-------|------|------|------------|
| 404.77 | 13.98 | 0.00 | 137.6 | 0.727E+00 | 5.18 | 47.70 | 5.18 | 0.00 | .73038E+04 |
| 406.06 | 13.98 | 0.00 | 138.1 | 0.724E+00 | 5.18 | 47.89 | 5.18 | 0.00 | .73249E+04 |
| 407.34 | 13.98 | 0.00 | 138.6 | 0.721E+00 | 5.18 | 48.07 | 5.18 | 0.00 | .73460E+04 |
| 408.63 | 13.98 | 0.00 | 139.1 | 0.719E+00 | 5.18 | 48.25 | 5.18 | 0.00 | .73671E+04 |
| 409.92 | 13.98 | 0.00 | 139.7 | 0.716E+00 | 5.18 | 48.43 | 5.18 | 0.00 | .73882E+04 |
| 411.20 | 13.98 | 0.00 | 140.2 | 0.713E+00 | 5.18 | 48.61 | 5.18 | 0.00 | .74093E+04 |
| 412.49 | 13.98 | 0.00 | 140.7 | 0.711E+00 | 5.18 | 48.79 | 5.18 | 0.00 | .74304E+04 |
| 413.78 | 13.98 | 0.00 | 141.2 | 0.708E+00 | 5.18 | 48.97 | 5.18 | 0.00 | .74516E+04 |
| 415.07 | 13.98 | 0.00 | 141.8 | 0.705E+00 | 5.18 | 49.16 | 5.18 | 0.00 | .74727E+04 |
| 416.35 | 13.98 | 0.00 | 142.3 | 0.703E+00 | 5.18 | 49.34 | 5.18 | 0.00 | .74938E+04 |
| 417.64 | 13.98 | 0.00 | 142.8 | 0.700E+00 | 5.18 | 49.52 | 5.18 | 0.00 | .75149E+04 |
| 418.93 | 13.98 | 0.00 | 143.3 | 0.698E+00 | 5.18 | 49.70 | 5.18 | 0.00 | .75360E+04 |
| 420.21 | 13.98 | 0.00 | 143.9 | 0.695E+00 | 5.18 | 49.89 | 5.18 | 0.00 | .75571E+04 |
| 421.50 | 13.98 | 0.00 | 144.4 | 0.693E+00 | 5.18 | 50.07 | 5.18 | 0.00 | .75782E+04 |
| 422.79 | 13.98 | 0.00 | 144.9 | 0.690E+00 | 5.18 | 50.25 | 5.18 | 0.00 | .75993E+04 |
| 424.07 | 13.98 | 0.00 | 145.4 | 0.688E+00 | 5.18 | 50.44 | 5.18 | 0.00 | .76204E+04 |
| 425.36 | 13.98 | 0.00 | 146.0 | 0.685E+00 | 5.18 | 50.62 | 5.18 | 0.00 | .76415E+04 |
| 426.65 | 13.98 | 0.00 | 146.5 | 0.683E+00 | 5.18 | 50.80 | 5.18 | 0.00 | .76627E+04 |
| 427.93 | 13.98 | 0.00 | 147.0 | 0.680E+00 | 5.18 | 50.99 | 5.18 | 0.00 | .76838E+04 |
| 429.22 | 13.98 | 0.00 | 147.6 | 0.678E+00 | 5.18 | 51.17 | 5.18 | 0.00 | .77049E+04 |
| 430.51 | 13.98 | 0.00 | 148.1 | 0.675E+00 | 5.18 | 51.36 | 5.18 | 0.00 | .77260E+04 |
| 431.79 | 13.98 | 0.00 | 148.6 | 0.673E+00 | 5.18 | 51.54 | 5.18 | 0.00 | .77471E+04 |
| 433.08 | 13.98 | 0.00 | 149.2 | 0.670E+00 | 5.18 | 51.73 | 5.18 | 0.00 | .77682E+04 |
| 434.37 | 13.98 | 0.00 | 149.7 | 0.668E+00 | 5.18 | 51.91 | 5.18 | 0.00 | .77893E+04 |
| 435.66 | 13.98 | 0.00 | 150.2 | 0.666E+00 | 5.18 | 52.10 | 5.18 | 0.00 | .78104E+04 |
| 436.94 | 13.98 | 0.00 | 150.8 | 0.663E+00 | 5.18 | 52.28 | 5.18 | 0.00 | .78315E+04 |
| 438.23 | 13.98 | 0.00 | 151.3 | 0.661E+00 | 5.18 | 52.47 | 5.18 | 0.00 | .78526E+04 |
| 439.52 | 13.98 | 0.00 | 151.9 | 0.659E+00 | 5.18 | 52.66 | 5.18 | 0.00 | .78738E+04 |
| 440.80 | 13.98 | 0.00 | 152.4 | 0.656E+00 | 5.18 | 52.84 | 5.18 | 0.00 | .78949E+04 |
| 442.09 | 13.98 | 0.00 | 152.9 | 0.654E+00 | 5.18 | 53.03 | 5.18 | 0.00 | .79160E+04 |
| 443.38 | 13.98 | 0.00 | 153.5 | 0.652E+00 | 5.18 | 53.22 | 5.18 | 0.00 | .79371E+04 |
| 444.66 | 13.98 | 0.00 | 154.0 | 0.649E+00 | 5.18 | 53.40 | 5.18 | 0.00 | .79582E+04 |
| 445.95 | 13.98 | 0.00 | 154.6 | 0.647E+00 | 5.18 | 53.59 | 5.18 | 0.00 | .79793E+04 |
| 447.24 | 13.98 | 0.00 | 155.1 | 0.645E+00 | 5.18 | 53.78 | 5.18 | 0.00 | .80004E+04 |
| 448.52 | 13.98 | 0.00 | 155.6 | 0.643E+00 | 5.18 | 53.97 | 5.18 | 0.00 | .80215E+04 |
| 449.81 | 13.98 | 0.00 | 156.2 | 0.640E+00 | 5.18 | 54.16 | 5.18 | 0.00 | .80426E+04 |
| 451.10 | 13.98 | 0.00 | 156.7 | 0.638E+00 | 5.18 | 54.34 | 5.18 | 0.00 | .80637E+04 |
| 452.38 | 13.98 | 0.00 | 157.3 | 0.636E+00 | 5.18 | 54.53 | 5.18 | 0.00 | .80849E+04 |
| 453.67 | 13.98 | 0.00 | 157.8 | 0.634E+00 | 5.18 | 54.72 | 5.18 | 0.00 | .81060E+04 |
| 454.96 | 13.98 | 0.00 | 158.4 | 0.632E+00 | 5.18 | 54.91 | 5.18 | 0.00 | .81271E+04 |
| 456.25 | 13.98 | 0.00 | 158.9 | 0.629E+00 | 5.18 | 55.10 | 5.18 | 0.00 | .81482E+04 |
| 457.53 | 13.98 | 0.00 | 159.4 | 0.627E+00 | 5.18 | 55.29 | 5.18 | 0.00 | .81693E+04 |
| 458.82 | 13.98 | 0.00 | 160.0 | 0.625E+00 | 5.18 | 55.48 | 5.18 | 0.00 | .81904E+04 |
| 460.11 | 13.98 | 0.00 | 160.5 | 0.623E+00 | 5.18 | 55.67 | 5.18 | 0.00 | .82115E+04 |
| 461.39 | 13.98 | 0.00 | 161.1 | 0.621E+00 | 5.18 | 55.86 | 5.18 | 0.00 | .82326E+04 |
| 462.68 | 13.98 | 0.00 | 161.6 | 0.619E+00 | 5.18 | 56.05 | 5.18 | 0.00 | .82537E+04 |
| 463.97 | 13.98 | 0.00 | 162.2 | 0.617E+00 | 5.18 | 56.24 | 5.18 | 0.00 | .82748E+04 |
| 465.25 | 13.98 | 0.00 | 162.7 | 0.615E+00 | 5.18 | 56.43 | 5.18 | 0.00 | .82960E+04 |
| 466.54 | 13.98 | 0.00 | 163.3 | 0.612E+00 | 5.18 | 56.62 | 5.18 | 0.00 | .83171E+04 |
| 467.83 | 13.98 | 0.00 | 163.8 | 0.610E+00 | 5.18 | 56.81 | 5.18 | 0.00 | .83382E+04 |
| 469.11 | 13.98 | 0.00 | 164.4 | 0.608E+00 | 5.18 | 57.00 | 5.18 | 0.00 | .83593E+04 |
| 470.40 | 13.98 | 0.00 | 164.9 | 0.606E+00 | 5.18 | 57.19 | 5.18 | 0.00 | .83804E+04 |
| 471.69 | 13.98 | 0.00 | 165.5 | 0.604E+00 | 5.18 | 57.39 | 5.18 | 0.00 | .84015E+04 |
| 472.97 | 13.98 | 0.00 | 166.0 | 0.602E+00 | 5.18 | 57.58 | 5.18 | 0.00 | .84226E+04 |
| 474.26 | 13.98 | 0.00 | 166.6 | 0.600E+00 | 5.18 | 57.77 | 5.18 | 0.00 | .84437E+04 |
| 475.55 | 13.98 | 0.00 | 167.2 | 0.598E+00 | 5.18 | 57.96 | 5.18 | 0.00 | .84648E+04 |
| 476.84 | 13.98 | 0.00 | 167.7 | 0.596E+00 | 5.18 | 58.16 | 5.18 | 0.00 | .84859E+04 |
| 478.12 | 13.98 | 0.00 | 168.3 | 0.594E+00 | 5.18 | 58.35 | 5.18 | 0.00 | .85071E+04 |
| 479.41 | 13.98 | 0.00 | 168.8 | 0.592E+00 | 5.18 | 58.54 | 5.18 | 0.00 | .85282E+04 |
| 480.70 | 13.98 | 0.00 | 169.4 | 0.590E+00 | 5.18 | 58.73 | 5.18 | 0.00 | .85493E+04 |
| 481.98 | 13.98 | 0.00 | 169.9 | 0.588E+00 | 5.18 | 58.93 | 5.18 | 0.00 | .85704E+04 |
| 483.27 | 13.98 | 0.00 | 170.5 | 0.587E+00 | 5.18 | 59.12 | 5.18 | 0.00 | .85915E+04 |
| 484.56 | 13.98 | 0.00 | 171.1 | 0.585E+00 | 5.18 | 59.32 | 5.18 | 0.00 | .86126E+04 |
| 485.84 | 13.98 | 0.00 | 171.6 | 0.583E+00 | 5.18 | 59.51 | 5.18 | 0.00 | .86337E+04 |
| 487.13 | 13.98 | 0.00 | 172.2 | 0.581E+00 | 5.18 | 59.70 | 5.18 | 0.00 | .86548E+04 |
| 488.42 | 13.98 | 0.00 | 172.7 | 0.579E+00 | 5.18 | 59.90 | 5.18 | 0.00 | .86759E+04 |
| 489.70 | 13.98 | 0.00 | 173.3 | 0.577E+00 | 5.18 | 60.09 | 5.18 | 0.00 | .86970E+04 |
| 490.99 | 13.98 | 0.00 | 173.9 | 0.575E+00 | 5.18 | 60.29 | 5.18 | 0.00 | .87182E+04 |

| | | | | | | | | | |
|--------------------------|-------|------|-------|---------------|-------------|-------|------|------|------------|
| 492.28 | 13.98 | 0.00 | 174.4 | 0.573E+00 | 5.18 | 60.48 | 5.18 | 0.00 | .87393E+04 |
| 493.56 | 13.98 | 0.00 | 175.0 | 0.571E+00 | 5.18 | 60.68 | 5.18 | 0.00 | .87604E+04 |
| 494.85 | 13.98 | 0.00 | 175.6 | 0.570E+00 | 5.18 | 60.87 | 5.18 | 0.00 | .87815E+04 |
| 496.14 | 13.98 | 0.00 | 176.1 | 0.568E+00 | 5.18 | 61.07 | 5.18 | 0.00 | .88026E+04 |
| 497.42 | 13.98 | 0.00 | 176.7 | 0.566E+00 | 5.18 | 61.27 | 5.18 | 0.00 | .88237E+04 |
| 498.71 | 13.98 | 0.00 | 177.2 | 0.564E+00 | 5.18 | 61.46 | 5.18 | 0.00 | .88448E+04 |
| 500.00 | 13.98 | 0.00 | 177.8 | 0.562E+00 | 5.18 | 61.66 | 5.18 | 0.00 | .88659E+04 |
| Cumulative travel time = | | | | 8865.9512 sec | (2.46 hrs) | | | | |

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Simulation limit based on maximum specified distance = 500.00 m.

This is the REGION OF INTEREST limitation.

END OF MOD261: PASSIVE AMBIENT MIXING IN UNIFORM AMBIENT

CORMIX2: Multiport Diffuser Discharges End of Prediction File

Appendix B: CORMIX Session Report for Uniform Ambient Density

CORMIX SESSION REPORT:
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CORMIX MIXING ZONE EXPERT SYSTEM
CORMIX Version 9.0GTD
HYDRO2:Version-9.0.0.0 September,2014
SITE NAME/LABEL: Pend Oreille River - Sandpoint outfall
DESIGN CASE: Sandpoint WWTP TP discharge to Pend Oreille River
FILE NAME: F:\My Folder\!\Permits!\Sandpoint\CORMIX Modeling\Using 2005
DEQ T Data\Unbounded\Sandpoint Measured Low Velocity 5 mgd uniform density unbounded
counterflow actual angle.prd
Using subsystem CORMIX2: Multiport Diffuser Discharges
Start of session: 09/09/2015--12:01:11

SUMMARY OF INPUT DATA:

AMBIENT PARAMETERS:
Cross-section = unbounded
Average depth HA = 6.71 m
Depth at discharge HD = 5.18 m
Ambient velocity UA = 0.0610 m/s
Darcy-Weisbach friction factor F = 0.0167
Calculated from Manning's n = 0.02
Wind velocity UW = 3.58 m/s
Stratification Type STRCND = U
Surface temperature = 21.30 degC
Bottom temperature = 21.30 degC
Calculated FRESH-WATER DENSITY values:
Surface density RHOAS = 997.9279 kg/m^3
Bottom density RHOAB = 997.9279 kg/m^3

DISCHARGE PARAMETERS:
Submerged Multiport Diffuser Discharge
Diffuser type DITYPE = unidirectional perpendicular
Diffuser length LD = 49.99 m
Nearest bank = left
Diffuser endpoints YB1 = 234.28 m; YB2 = 275.72 m
Number of openings NOPEN = 41
Number of Risers NRISER = 41
Ports/Nozzles per Riser NPPERR = 1
Spacing between risers/openings SPAC = 1.25 m
Port/Nozzle diameter D0 = 0.0762 m
with contraction ratio = 1
Equivalent slot width B0 = 0.0037 m
Total area of openings TAO = 0.1870 m^2
Discharge velocity U0 = 1.17 m/s
Total discharge flowrate Q0 = 0.219063 m^3/s
Discharge port height H0 = 0.41 m
Nozzle arrangement BETYPE = unidirectional without fanning
Diffuser alignment angle GAMMA = 56 deg
Vertical discharge angle THETA = 0 deg
Actual Vertical discharge angle THEAC = 0 deg
Horizontal discharge angle SIGMA = 146 deg
Relative orientation angle BETA = 90 deg
Discharge temperature (freshwater) = 21 degC
Corresponding density RHO0 = 997.9934 kg/m^3
Density difference DRHO = -0.0655 kg/m^3
Buoyant acceleration GPO = -0.0006 m/s^2
Discharge concentration CO = 100 %
Surface heat exchange coeff. KS = 0 m/s
Coefficient of decay KD = 0 /s

FLUX VARIABLES PER UNIT DIFFUSER LENGTH:

Discharge (volume flux) q0 = 0.004382 m^2/s
Momentum flux m0 = 0.005134 m^3/s^2
Buoyancy flux j0 = -0.000003 m^3/s^3

DISCHARGE/ENVIRONMENT LENGTH SCALES:

LQ = 0.00 m Lm = 1.38 m LM = 25.63 m
lm' = 99999 m Lb' = 99999 m La = 99999 m
(These refer to the actual discharge/environment length scales.)

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NON-DIMENSIONAL PARAMETERS:

Slot Froude number FRO = 754.93
Port/nozzle Froude number FRD0 = 167.26
Velocity ratio R = 19.22

MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:

Toxic discharge = no
Water quality standard specified = no
Regulatory mixing zone = no
Region of interest = 500 m downstream

HYDRODYNAMIC CLASSIFICATION:

| FLOW CLASS = MNUT7 |

This flow configuration applies to a layer corresponding to the full water depth at the discharge site.

Applicable layer depth = water depth = 5.18 m

MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

X-Y-Z Coordinate system:

Origin is located at the BOTTOM below the port/diffuser center:
255 m from the left bank/shore.
Number of display steps NSTEP = 100 per module.

NEAR-FIELD REGION (NFR) CONDITIONS :

Note: The NFR is the zone of strong initial mixing. It has no regulatory implication. However, this information may be useful for the discharge designer because the mixing in the NFR is usually sensitive to the discharge design conditions.

Pollutant concentration at NFR edge c = 2.2717 %

Dilution at edge of NFR s = 44.0

NFR Location:
(centerline coordinates) x = -20.72 m
y = 13.98 m
z = 0 m

NFR plume dimensions: half-width (bh) = 20.69 m
thickness (bv) = 5.18 m

Cumulative travel time: 323.9456 sec.

Buoyancy assessment:

The effluent density is greater than the surrounding ambient water density at the discharge level.
Therefore, the effluent is NEGATIVELY BUOYANT and will tend to sink towards the bottom.

IMPORTANT NOTE:

Since the effluent is NEGATIVELY BUOYANT, it is recommended that you consider using the Brine or Sediment options for Effluent specification for a more detailed analysis, particularly for coastal discharges over a sloping bottom where density currents are important.

CORMIX will however continue with the current simulation.

Near-field instability behavior:

The diffuser flow will experience instabilities with full vertical mixing in the near-field.

There may be benthic impact of high pollutant concentrations.

FAR-FIELD MIXING SUMMARY:

Plume is vertically fully mixed WITHIN NEAR-FIELD (or a fraction thereof), but RE-STRATIFIES LATER.

Plume becomes vertically fully mixed again at 372.60 m downstream.

PLUME BANK CONTACT SUMMARY:

Plume in unbounded section does not contact bank in this simulation.

***** TOXIC DILUTION ZONE SUMMARY *****

No TDZ was specified for this simulation.

***** REGULATORY MIXING ZONE SUMMARY *****

No RMZ and no ambient water quality standard have been specified.

***** FINAL DESIGN ADVICE AND COMMENTS *****

The diffuser ports or nozzles point towards the nearest bank.

Since this is an UNUSUAL DESIGN, check whether you have specified correctly the port/nozzle geometry (angles GAMMA, SIGMA and BETA).

CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent the actual three-dimensional diffuser geometry. Thus, it approximates the details of the merging process of the individual jets from each port/nozzle.

In the present design, the spacing between adjacent ports/nozzles (or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about +/- 50% (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.

Appendix C: CORMIX Prediction File for Stratified Ambient Density

CASE DESCRIPTION
Site name/label: Pend Oreille River - Sandpoint outfall
Design case: Sandpoint WWTP TP discharge to Pend Oreille River
FILE NAME: C:\...\y gradient unbounded counterflow actual angle.prd
Time stamp: Fri Oct 23 15:45:57 2015

ENVIRONMENT PARAMETERS (metric units)

```

Unbounded section
HA      =       6.71  HD      =      5.18
UA      =     0.061 F      =    0.017 USTAR = 0.2781E-02

```

```

UW      =   3.576 UWSTAR=0.4081E-02
Density stratified environment
STRCND= A          RHOAM = 998.0142
RHOAS = 997.9279  RHOAB = 998.1006  RHOAH0= 998.0870 E =0.3274E-03

```

```

DIFFUSER DISCHARGE PARAMETERS (metric units)
Diffuser type: DITYPE= unidirectional_perpendicular
BANK = LEFT DISTB = 255.00 YB1 = 234.28 YB2 = 275.7
LD = 49.99 NOPEN = 41 SPAC = 1.25
D0 = 0.076 A0 = 0.005 H0 = 0.41 SUBO = 4.7
D0INP = 0.076 CR0 = 1.000
Nozzle/port arrangement: unidirectional_without_fanning
GAMMA = 56.00 THETA = 0.00 SIGMA = 146.00 BETA = 90.0
U0 = 1.172 Q0 = 0.219 =0.2191E+00
RHO0 = 997.9934 DRHO0=0.9363E-01 GPO = 0.9199E-03
C0 = 0.1000E+03 CUNITS = %
TPOLJ = 1 KS = 0.0000E+00 KD = 0.0000E+00

```

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units) SIGNJO= 1.0
 $q_0 = 0.4382E-02$ $m_0 = 0.5134E-02$ $j_0 = 0.4032E-05$
 Associated B-d length scales (meters)
 $1B = 0.004 \text{ m} = 20.21 \text{ lm} = 1.38 \text{ lmp}$
 $1lm = 2.50 \text{ lbo} = 0.88 \text{ la} = 3.37 \text{ lje}$

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 $Q_0 = 0.2191E+00$ $M_0 = 0.2567E+00$ $J_0 = 0.2015E-03$
 Associated 3-d length scales (meters)
 $L_Q = 0.07$ $L_M = 25.40$ $L_m = 8.31$ $L_b = 0.89$
 $L_{Mp} = 5.29$ $L_{bp} = 2.42$

NON-DIMENSIONAL PARAMETERS
FRO = 631.57 FRD0 = 139.93 R = 19.22 PL = 6.01
(solar) (part/nozzle) (part)

```

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
Properties of riser group with 1 ports/nozzles each:
U0      =      1.172 D0      =      0.076 A0      =      0.005 THETA =      0.00
FR0     =    631.57 FRDO   =    139.93 R      =      19.22
          (slot)           (riser group)

```

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
C0 = 0.1000E+03 CUNITS= %

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```

NTOX = 0
NSTD = 0
REGMZ = 0
XINT = 500.00 XMAX = 500.00

```

X-Y-Z COORDINATE SYSTEM:

ORIGIN is located at the bottom and the diffuser mid-point:
 255.00 m from the LEFT bank/shore.
 X-axis points downstream, Y-axis points to left, Z-axis points upward.

NSTEP = 100 display intervals per module

BEGIN MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

| X | Y | Z | S | C | BV | BH | Uc | TT |
|------|------|------|-----|-----------|------|------|-------|------------|
| 0.00 | 0.00 | 0.41 | 1.0 | 0.100E+03 | 0.04 | 0.04 | 1.222 | .00000E+00 |

END OF MOD101: DISCHARGE MODULE (SINGLE PORT AT DIFFUSER CENTER)

BEGIN CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

Jet-like motion in linear stratification with strong crossflow.

Zone of flow establishment: THETAE= 0.00 SIGMAE= 145.30
 LE = 0.35 XE = -0.29 YE = 0.19 ZE = 0.41

Profile definitions:

BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
 BH = before merging: Gaussian 1/e (37%) half-width in horizontal plane
 normal to trajectory

after merging: top-hat half-width in horizontal plane
 parallel to diffuser line

S = hydrodynamic centerline dilution

C = centerline concentration (includes reaction effects, if any)

Uc = Local centerline excess velocity (above ambient)

TT = Cumulative travel time

| X | Y | Z | S | C | BV | BH | Uc | TT |
|-----------------------------------------------------------|------|------|------|-----------|------|-------|-------|------------|
| Individual jet/plumes before merging: | | | | | | | | |
| -0.29 | 0.19 | 0.41 | 1.0 | 0.100E+03 | 0.04 | 0.04 | 1.222 | .00000E+00 |
| -0.29 | 0.19 | 0.41 | 1.0 | 0.100E+03 | 0.04 | 0.04 | 1.222 | .22219E-02 |
| Merging of individual jet/plumes to form plane jet/plume: | | | | | | | | |
| -0.30 | 0.24 | 0.41 | 1.6 | 0.644E+02 | 0.00 | 24.99 | 1.222 | .40117E-01 |
| Maximum jet height has been reached. | | | | | | | | |
| Minimum jet height has been reached. | | | | | | | | |
| 0.31 | 0.24 | 0.41 | 17.1 | 0.585E+01 | 0.08 | 25.07 | 0.566 | .71637E+00 |
| 0.65 | 0.24 | 0.41 | 21.3 | 0.469E+01 | 0.12 | 25.11 | 0.454 | .13145E+01 |
| 0.98 | 0.24 | 0.41 | 24.9 | 0.401E+01 | 0.16 | 25.15 | 0.390 | .20163E+01 |
| 1.32 | 0.24 | 0.41 | 28.1 | 0.356E+01 | 0.19 | 25.19 | 0.347 | .28041E+01 |
| 1.66 | 0.24 | 0.41 | 30.9 | 0.323E+01 | 0.23 | 25.22 | 0.315 | .36661E+01 |
| 1.99 | 0.24 | 0.41 | 33.6 | 0.298E+01 | 0.27 | 25.26 | 0.290 | .45938E+01 |
| 2.33 | 0.24 | 0.41 | 36.0 | 0.277E+01 | 0.30 | 25.30 | 0.271 | .55809E+01 |
| 2.66 | 0.24 | 0.41 | 38.4 | 0.261E+01 | 0.34 | 25.33 | 0.255 | .66221E+01 |
| 3.00 | 0.24 | 0.41 | 40.6 | 0.246E+01 | 0.37 | 25.36 | 0.241 | .77134E+01 |
| 3.34 | 0.24 | 0.41 | 42.7 | 0.234E+01 | 0.40 | 25.40 | 0.229 | .88510E+01 |
| 3.67 | 0.24 | 0.41 | 44.7 | 0.224E+01 | 0.44 | 25.43 | 0.219 | .10032E+02 |
| 4.01 | 0.24 | 0.41 | 46.6 | 0.214E+01 | 0.47 | 25.46 | 0.210 | .11254E+02 |
| 4.35 | 0.24 | 0.41 | 48.5 | 0.206E+01 | 0.50 | 25.49 | 0.202 | .12515E+02 |
| 4.69 | 0.24 | 0.41 | 50.3 | 0.199E+01 | 0.53 | 25.53 | 0.195 | .13827E+02 |
| 5.03 | 0.24 | 0.41 | 52.1 | 0.192E+01 | 0.56 | 25.56 | 0.189 | .15159E+02 |
| 5.36 | 0.24 | 0.41 | 53.8 | 0.186E+01 | 0.59 | 25.59 | 0.183 | .16525E+02 |
| 5.70 | 0.24 | 0.41 | 55.4 | 0.180E+01 | 0.62 | 25.62 | 0.177 | .17923E+02 |
| 6.04 | 0.24 | 0.41 | 57.0 | 0.175E+01 | 0.65 | 25.65 | 0.172 | .19351E+02 |
| 6.37 | 0.24 | 0.41 | 58.6 | 0.171E+01 | 0.68 | 25.68 | 0.168 | .20808E+02 |
| 6.71 | 0.24 | 0.41 | 60.1 | 0.166E+01 | 0.71 | 25.71 | 0.164 | .22294E+02 |
| 7.05 | 0.24 | 0.41 | 61.7 | 0.162E+01 | 0.74 | 25.74 | 0.160 | .23806E+02 |
| 7.38 | 0.24 | 0.41 | 63.1 | 0.158E+01 | 0.77 | 25.76 | 0.156 | .25345E+02 |

| | | | | | | | | |
|-------|------|------|-------|-----------|------|-------|-------|------------|
| 7.72 | 0.24 | 0.41 | 64.6 | 0.155E+01 | 0.80 | 25.79 | 0.153 | .26909E+02 |
| 8.05 | 0.24 | 0.41 | 66.0 | 0.152E+01 | 0.83 | 25.82 | 0.149 | .28498E+02 |
| 8.39 | 0.24 | 0.41 | 67.4 | 0.148E+01 | 0.86 | 25.85 | 0.146 | .30110E+02 |
| 8.73 | 0.24 | 0.41 | 68.7 | 0.145E+01 | 0.88 | 25.88 | 0.143 | .31746E+02 |
| 9.07 | 0.24 | 0.41 | 70.1 | 0.143E+01 | 0.91 | 25.91 | 0.141 | .33422E+02 |
| 9.41 | 0.24 | 0.41 | 71.4 | 0.140E+01 | 0.94 | 25.93 | 0.138 | .35102E+02 |
| 9.74 | 0.24 | 0.41 | 72.7 | 0.138E+01 | 0.97 | 25.96 | 0.136 | .36803E+02 |
| 10.08 | 0.24 | 0.41 | 74.0 | 0.135E+01 | 0.99 | 25.99 | 0.133 | .38524E+02 |
| 10.42 | 0.24 | 0.41 | 75.3 | 0.133E+01 | 1.02 | 26.01 | 0.131 | .40266E+02 |
| 10.75 | 0.24 | 0.41 | 76.5 | 0.131E+01 | 1.05 | 26.04 | 0.129 | .42027E+02 |
| 11.09 | 0.24 | 0.41 | 77.7 | 0.129E+01 | 1.07 | 26.07 | 0.127 | .43807E+02 |
| 11.43 | 0.24 | 0.41 | 78.9 | 0.127E+01 | 1.10 | 26.09 | 0.125 | .45605E+02 |
| 11.76 | 0.24 | 0.41 | 80.1 | 0.125E+01 | 1.13 | 26.12 | 0.123 | .47422E+02 |
| 12.10 | 0.24 | 0.41 | 81.3 | 0.123E+01 | 1.15 | 26.15 | 0.122 | .49257E+02 |
| 12.44 | 0.24 | 0.41 | 82.5 | 0.121E+01 | 1.18 | 26.17 | 0.120 | .51109E+02 |
| 12.77 | 0.24 | 0.41 | 83.6 | 0.120E+01 | 1.20 | 26.20 | 0.118 | .52978E+02 |
| 13.11 | 0.24 | 0.42 | 84.8 | 0.118E+01 | 1.23 | 26.22 | 0.117 | .54864E+02 |
| 13.44 | 0.24 | 0.42 | 85.9 | 0.116E+01 | 1.25 | 26.25 | 0.115 | .56766E+02 |
| 13.79 | 0.24 | 0.42 | 87.0 | 0.115E+01 | 1.28 | 26.27 | 0.114 | .58705E+02 |
| 14.12 | 0.24 | 0.42 | 88.1 | 0.113E+01 | 1.30 | 26.30 | 0.112 | .60638E+02 |
| 14.46 | 0.24 | 0.42 | 89.2 | 0.112E+01 | 1.33 | 26.32 | 0.111 | .62587E+02 |
| 14.80 | 0.24 | 0.42 | 90.3 | 0.111E+01 | 1.35 | 26.35 | 0.110 | .64552E+02 |
| 15.13 | 0.24 | 0.42 | 91.3 | 0.109E+01 | 1.38 | 26.37 | 0.109 | .66530E+02 |
| 15.47 | 0.24 | 0.42 | 92.4 | 0.108E+01 | 1.40 | 26.40 | 0.107 | .68524E+02 |
| 15.81 | 0.24 | 0.42 | 93.4 | 0.107E+01 | 1.43 | 26.42 | 0.106 | .70531E+02 |
| 16.14 | 0.24 | 0.42 | 94.5 | 0.106E+01 | 1.45 | 26.44 | 0.105 | .72552E+02 |
| 16.48 | 0.24 | 0.42 | 95.5 | 0.105E+01 | 1.48 | 26.47 | 0.104 | .74588E+02 |
| 16.82 | 0.24 | 0.42 | 96.5 | 0.104E+01 | 1.50 | 26.49 | 0.103 | .76636E+02 |
| 17.15 | 0.24 | 0.42 | 97.5 | 0.103E+01 | 1.52 | 26.52 | 0.102 | .78698E+02 |
| 17.49 | 0.24 | 0.42 | 98.5 | 0.101E+01 | 1.55 | 26.54 | 0.101 | .80773E+02 |
| 17.83 | 0.24 | 0.42 | 99.5 | 0.100E+01 | 1.57 | 26.56 | 0.100 | .82861E+02 |
| 18.16 | 0.24 | 0.42 | 100.5 | 0.995E+00 | 1.59 | 26.59 | 0.099 | .84961E+02 |
| 18.50 | 0.24 | 0.42 | 101.5 | 0.985E+00 | 1.62 | 26.61 | 0.098 | .87098E+02 |
| 18.84 | 0.24 | 0.42 | 102.4 | 0.976E+00 | 1.64 | 26.63 | 0.097 | .89223E+02 |
| 19.18 | 0.24 | 0.42 | 103.4 | 0.967E+00 | 1.66 | 26.66 | 0.096 | .91360E+02 |
| 19.51 | 0.24 | 0.42 | 104.3 | 0.958E+00 | 1.69 | 26.68 | 0.095 | .93509E+02 |
| 19.85 | 0.24 | 0.42 | 105.3 | 0.950E+00 | 1.71 | 26.70 | 0.094 | .95670E+02 |
| 20.19 | 0.24 | 0.42 | 106.2 | 0.941E+00 | 1.73 | 26.72 | 0.094 | .97842E+02 |
| 20.52 | 0.24 | 0.42 | 107.1 | 0.933E+00 | 1.75 | 26.75 | 0.093 | .10003E+03 |
| 20.86 | 0.24 | 0.42 | 108.1 | 0.925E+00 | 1.78 | 26.77 | 0.092 | .10222E+03 |
| 21.20 | 0.24 | 0.42 | 109.0 | 0.918E+00 | 1.80 | 26.79 | 0.091 | .10443E+03 |
| 21.53 | 0.24 | 0.42 | 109.9 | 0.910E+00 | 1.82 | 26.81 | 0.091 | .10664E+03 |
| 21.87 | 0.24 | 0.42 | 110.8 | 0.903E+00 | 1.84 | 26.84 | 0.090 | .10887E+03 |
| 22.21 | 0.24 | 0.42 | 111.7 | 0.895E+00 | 1.87 | 26.86 | 0.089 | .11111E+03 |
| 22.54 | 0.24 | 0.42 | 112.6 | 0.888E+00 | 1.89 | 26.88 | 0.088 | .11336E+03 |
| 22.88 | 0.24 | 0.42 | 113.5 | 0.881E+00 | 1.91 | 26.90 | 0.088 | .11564E+03 |
| 23.22 | 0.24 | 0.42 | 114.3 | 0.875E+00 | 1.93 | 26.92 | 0.087 | .11791E+03 |
| 23.56 | 0.24 | 0.42 | 115.2 | 0.868E+00 | 1.95 | 26.95 | 0.086 | .12019E+03 |
| 23.89 | 0.24 | 0.42 | 116.1 | 0.862E+00 | 1.97 | 26.97 | 0.086 | .12248E+03 |
| 24.23 | 0.24 | 0.43 | 116.9 | 0.855E+00 | 2.00 | 26.99 | 0.085 | .12477E+03 |
| 24.57 | 0.24 | 0.43 | 117.8 | 0.849E+00 | 2.02 | 27.01 | 0.085 | .12708E+03 |
| 24.90 | 0.24 | 0.43 | 118.6 | 0.843E+00 | 2.04 | 27.03 | 0.084 | .12940E+03 |
| 25.24 | 0.24 | 0.43 | 119.5 | 0.837E+00 | 2.06 | 27.05 | 0.083 | .13173E+03 |
| 25.58 | 0.24 | 0.43 | 120.3 | 0.831E+00 | 2.08 | 27.07 | 0.083 | .13406E+03 |
| 25.91 | 0.24 | 0.43 | 121.1 | 0.825E+00 | 2.10 | 27.10 | 0.082 | .13641E+03 |
| 26.25 | 0.24 | 0.43 | 122.0 | 0.820E+00 | 2.12 | 27.12 | 0.082 | .13876E+03 |
| 26.59 | 0.24 | 0.43 | 122.8 | 0.814E+00 | 2.14 | 27.14 | 0.081 | .14113E+03 |
| 26.92 | 0.24 | 0.43 | 123.6 | 0.809E+00 | 2.16 | 27.16 | 0.081 | .14350E+03 |
| 27.26 | 0.24 | 0.43 | 124.4 | 0.804E+00 | 2.19 | 27.18 | 0.080 | .14588E+03 |
| 27.60 | 0.24 | 0.43 | 125.2 | 0.798E+00 | 2.21 | 27.20 | 0.080 | .14830E+03 |
| 27.94 | 0.24 | 0.43 | 126.0 | 0.793E+00 | 2.23 | 27.22 | 0.079 | .15070E+03 |
| 28.27 | 0.24 | 0.43 | 126.8 | 0.788E+00 | 2.25 | 27.24 | 0.079 | .15310E+03 |
| 28.61 | 0.24 | 0.43 | 127.6 | 0.783E+00 | 2.27 | 27.26 | 0.078 | .15552E+03 |
| 28.95 | 0.24 | 0.43 | 128.4 | 0.779E+00 | 2.29 | 27.28 | 0.078 | .15794E+03 |
| 29.28 | 0.24 | 0.43 | 129.2 | 0.774E+00 | 2.31 | 27.30 | 0.077 | .16038E+03 |
| 29.62 | 0.24 | 0.43 | 130.0 | 0.769E+00 | 2.33 | 27.32 | 0.077 | .16282E+03 |
| 29.96 | 0.24 | 0.43 | 130.8 | 0.765E+00 | 2.35 | 27.34 | 0.076 | .16526E+03 |
| 30.29 | 0.24 | 0.43 | 131.6 | 0.760E+00 | 2.37 | 27.36 | 0.076 | .16772E+03 |

| | | | | | | | | |
|-------|------|------|-------|-----------|------|-------|-------|------------|
| 30.63 | 0.24 | 0.43 | 132.3 | 0.756E+00 | 2.39 | 27.38 | 0.075 | .17018E+03 |
| 30.97 | 0.24 | 0.43 | 133.1 | 0.751E+00 | 2.41 | 27.40 | 0.075 | .17266E+03 |
| 31.30 | 0.24 | 0.43 | 133.9 | 0.747E+00 | 2.43 | 27.42 | 0.075 | .17513E+03 |
| 31.64 | 0.24 | 0.43 | 134.6 | 0.743E+00 | 2.45 | 27.44 | 0.074 | .17762E+03 |
| 31.98 | 0.24 | 0.43 | 135.4 | 0.739E+00 | 2.47 | 27.46 | 0.074 | .18012E+03 |
| 32.31 | 0.24 | 0.43 | 136.1 | 0.735E+00 | 2.49 | 27.48 | 0.073 | .18262E+03 |
| 32.65 | 0.24 | 0.43 | 136.9 | 0.731E+00 | 2.51 | 27.50 | 0.073 | .18513E+03 |
| 32.99 | 0.24 | 0.43 | 137.6 | 0.727E+00 | 2.53 | 27.52 | 0.073 | .18764E+03 |
| 33.32 | 0.24 | 0.43 | 138.4 | 0.723E+00 | 2.55 | 27.54 | 0.072 | .19017E+03 |

Terminal level in stratified ambient has been reached.

Cumulative travel time = 190.1680 sec (0.05 hrs)

END OF CORJET (MOD110): JET/PLUME NEAR-FIELD MIXING REGION

BEGIN MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH

Control volume inflow:

| X | Y | Z | S | C | BV | BH | TT |
|-------|------|------|-------|-----------|------|-------|------------|
| 33.32 | 0.24 | 0.43 | 138.4 | 0.723E+00 | 2.55 | 27.54 | .19017E+03 |

Profile definitions:

BV = top-hat thickness, measured vertically
 BH = top-hat half-width, measured horizontally in y-direction
 ZU = upper plume boundary (Z-coordinate)
 ZL = lower plume boundary (Z-coordinate)
 S = hydrodynamic average (bulk) dilution
 C = average (bulk) concentration (includes reaction effects, if any)
 TT = Cumulative travel time

| X | Y | Z | S | C | BV | BH | ZU | ZL | TT |
|-------|------|------|-------|-----------|------|-------|------|------|------------|
| 30.77 | 0.24 | 0.43 | 138.4 | 0.723E+00 | 0.00 | 0.00 | 0.43 | 0.43 | .19017E+03 |
| 32.30 | 0.24 | 0.43 | 138.4 | 0.723E+00 | 3.86 | 30.57 | 3.86 | 0.00 | .19017E+03 |
| 33.83 | 0.24 | 0.43 | 140.7 | 0.711E+00 | 4.54 | 68.06 | 4.54 | 0.00 | .19852E+03 |
| 35.36 | 0.24 | 0.43 | 166.1 | 0.602E+00 | 4.91 | 68.16 | 4.91 | 0.00 | .22359E+03 |
| 36.89 | 0.24 | 0.43 | 188.8 | 0.530E+00 | 5.12 | 68.25 | 5.12 | 0.00 | .24866E+03 |
| 38.42 | 0.24 | 0.43 | 197.1 | 0.507E+00 | 5.18 | 68.35 | 5.18 | 0.00 | .27372E+03 |

Cumulative travel time = 273.7231 sec (0.08 hrs)

END OF MOD235: LAYER/BOUNDARY/TERMINAL LAYER APPROACH

** End of NEAR-FIELD REGION (NFR) **

BEGIN MOD242: BUOYANT TERMINAL LAYER SPREADING

Profile definitions:

BV = top-hat thickness, measured vertically
 BH = top-hat half-width, measured horizontally in y-direction
 ZU = upper plume boundary (Z-coordinate)
 ZL = lower plume boundary (Z-coordinate)
 S = hydrodynamic average (bulk) dilution
 C = average (bulk) concentration (includes reaction effects, if any)
 TT = Cumulative travel time

Plume Stage 1 (not bank attached):

| X | Y | Z | S | C | BV | BH | ZU | ZL | TT |
|-------|------|------|-------|-----------|------|--------|------|------|------------|
| 38.42 | 0.24 | 0.43 | 197.1 | 0.507E+00 | 5.18 | 68.35 | 5.18 | 0.00 | .27372E+03 |
| 41.63 | 0.24 | 0.43 | 199.6 | 0.501E+00 | 4.99 | 71.92 | 4.99 | 0.00 | .32643E+03 |
| 44.84 | 0.24 | 0.43 | 202.0 | 0.495E+00 | 4.82 | 75.36 | 4.82 | 0.00 | .37913E+03 |
| 48.05 | 0.24 | 0.43 | 204.2 | 0.490E+00 | 4.66 | 78.68 | 4.66 | 0.00 | .43184E+03 |
| 51.27 | 0.24 | 0.43 | 206.3 | 0.485E+00 | 4.53 | 81.90 | 4.53 | 0.00 | .48454E+03 |
| 54.48 | 0.24 | 0.43 | 208.2 | 0.480E+00 | 4.40 | 85.03 | 4.40 | 0.00 | .53725E+03 |
| 57.69 | 0.24 | 0.43 | 210.1 | 0.476E+00 | 4.29 | 88.06 | 4.29 | 0.00 | .58995E+03 |
| 60.91 | 0.24 | 0.43 | 211.9 | 0.472E+00 | 4.18 | 91.02 | 4.18 | 0.00 | .64265E+03 |
| 64.12 | 0.24 | 0.43 | 213.5 | 0.468E+00 | 4.09 | 93.91 | 4.09 | 0.00 | .69536E+03 |
| 67.33 | 0.24 | 0.43 | 215.2 | 0.465E+00 | 4.00 | 96.72 | 4.00 | 0.00 | .74806E+03 |
| 70.54 | 0.24 | 0.43 | 216.7 | 0.461E+00 | 3.91 | 99.48 | 3.91 | 0.00 | .80077E+03 |
| 73.76 | 0.24 | 0.43 | 218.2 | 0.458E+00 | 3.84 | 102.17 | 3.84 | 0.00 | .85347E+03 |

| | | | | | | | | | |
|--------|------|------|-------|-----------|------|--------|------|------|------------|
| 76.97 | 0.24 | 0.43 | 219.6 | 0.455E+00 | 3.76 | 104.82 | 3.76 | 0.00 | .90618E+03 |
| 80.18 | 0.24 | 0.43 | 221.0 | 0.453E+00 | 3.70 | 107.41 | 3.70 | 0.00 | .95888E+03 |
| 83.40 | 0.24 | 0.43 | 222.3 | 0.450E+00 | 3.63 | 109.95 | 3.63 | 0.00 | .10116E+04 |
| 86.61 | 0.24 | 0.43 | 223.6 | 0.447E+00 | 3.57 | 112.45 | 3.57 | 0.00 | .10643E+04 |
| 89.82 | 0.24 | 0.43 | 224.8 | 0.445E+00 | 3.52 | 114.90 | 3.52 | 0.00 | .11170E+04 |
| 93.03 | 0.24 | 0.43 | 226.0 | 0.442E+00 | 3.46 | 117.31 | 3.46 | 0.00 | .11697E+04 |
| 96.25 | 0.24 | 0.43 | 227.2 | 0.440E+00 | 3.41 | 119.69 | 3.41 | 0.00 | .12224E+04 |
| 99.46 | 0.24 | 0.43 | 228.3 | 0.438E+00 | 3.36 | 122.03 | 3.36 | 0.00 | .12751E+04 |
| 102.67 | 0.24 | 0.43 | 229.4 | 0.436E+00 | 3.32 | 124.33 | 3.32 | 0.00 | .13278E+04 |
| 105.89 | 0.24 | 0.43 | 230.5 | 0.434E+00 | 3.27 | 126.60 | 3.27 | 0.00 | .13805E+04 |
| 109.10 | 0.24 | 0.43 | 231.5 | 0.432E+00 | 3.23 | 128.84 | 3.23 | 0.00 | .14332E+04 |
| 112.31 | 0.24 | 0.43 | 232.5 | 0.430E+00 | 3.19 | 131.04 | 3.19 | 0.00 | .14859E+04 |
| 115.52 | 0.24 | 0.43 | 233.5 | 0.428E+00 | 3.15 | 133.22 | 3.15 | 0.00 | .15386E+04 |
| 118.74 | 0.24 | 0.43 | 234.5 | 0.426E+00 | 3.11 | 135.37 | 3.11 | 0.00 | .15913E+04 |
| 121.95 | 0.24 | 0.43 | 235.4 | 0.425E+00 | 3.08 | 137.50 | 3.08 | 0.00 | .16440E+04 |
| 125.16 | 0.24 | 0.43 | 236.4 | 0.423E+00 | 3.04 | 139.59 | 3.04 | 0.00 | .16967E+04 |
| 128.38 | 0.24 | 0.43 | 237.3 | 0.421E+00 | 3.01 | 141.66 | 3.01 | 0.00 | .17494E+04 |
| 131.59 | 0.24 | 0.43 | 238.2 | 0.420E+00 | 2.98 | 143.71 | 2.98 | 0.00 | .18022E+04 |
| 134.80 | 0.24 | 0.43 | 239.1 | 0.418E+00 | 2.95 | 145.74 | 2.95 | 0.00 | .18549E+04 |
| 138.01 | 0.24 | 0.43 | 239.9 | 0.417E+00 | 2.92 | 147.74 | 2.92 | 0.00 | .19076E+04 |
| 141.23 | 0.24 | 0.43 | 240.8 | 0.415E+00 | 2.89 | 149.72 | 2.89 | 0.00 | .19603E+04 |
| 144.44 | 0.24 | 0.43 | 241.6 | 0.414E+00 | 2.86 | 151.68 | 2.86 | 0.00 | .20130E+04 |
| 147.65 | 0.24 | 0.43 | 242.4 | 0.413E+00 | 2.84 | 153.62 | 2.84 | 0.00 | .20657E+04 |
| 150.87 | 0.24 | 0.43 | 243.2 | 0.411E+00 | 2.81 | 155.54 | 2.81 | 0.00 | .21184E+04 |
| 154.08 | 0.24 | 0.43 | 244.0 | 0.410E+00 | 2.78 | 157.44 | 2.78 | 0.00 | .21711E+04 |
| 157.29 | 0.24 | 0.43 | 244.8 | 0.409E+00 | 2.76 | 159.33 | 2.76 | 0.00 | .22238E+04 |
| 160.50 | 0.24 | 0.43 | 245.5 | 0.407E+00 | 2.74 | 161.19 | 2.74 | 0.00 | .22765E+04 |
| 163.72 | 0.24 | 0.43 | 246.3 | 0.406E+00 | 2.71 | 163.04 | 2.71 | 0.00 | .23292E+04 |
| 166.93 | 0.24 | 0.43 | 247.0 | 0.405E+00 | 2.69 | 164.87 | 2.69 | 0.00 | .23819E+04 |
| 170.14 | 0.24 | 0.43 | 247.8 | 0.404E+00 | 2.67 | 166.69 | 2.67 | 0.00 | .24346E+04 |
| 173.36 | 0.24 | 0.43 | 248.5 | 0.402E+00 | 2.65 | 168.48 | 2.65 | 0.00 | .24873E+04 |
| 176.57 | 0.24 | 0.43 | 249.2 | 0.401E+00 | 2.63 | 170.27 | 2.63 | 0.00 | .25400E+04 |
| 179.78 | 0.24 | 0.43 | 249.9 | 0.400E+00 | 2.61 | 172.04 | 2.61 | 0.00 | .25927E+04 |
| 182.99 | 0.24 | 0.43 | 250.6 | 0.399E+00 | 2.59 | 173.79 | 2.59 | 0.00 | .26454E+04 |
| 186.21 | 0.24 | 0.43 | 251.3 | 0.398E+00 | 2.57 | 175.53 | 2.57 | 0.00 | .26981E+04 |
| 189.42 | 0.24 | 0.43 | 251.9 | 0.397E+00 | 2.55 | 177.25 | 2.55 | 0.00 | .27508E+04 |
| 192.63 | 0.24 | 0.43 | 252.6 | 0.396E+00 | 2.54 | 178.97 | 2.54 | 0.00 | .28035E+04 |
| 195.85 | 0.24 | 0.43 | 253.3 | 0.395E+00 | 2.52 | 180.66 | 2.52 | 0.00 | .28562E+04 |
| 199.06 | 0.24 | 0.43 | 253.9 | 0.394E+00 | 2.50 | 182.35 | 2.50 | 0.00 | .29098E+04 |
| 202.27 | 0.24 | 0.43 | 254.6 | 0.393E+00 | 2.49 | 184.02 | 2.49 | 0.00 | .29616E+04 |
| 205.48 | 0.24 | 0.43 | 255.2 | 0.392E+00 | 2.47 | 185.68 | 2.47 | 0.00 | .30144E+04 |
| 208.70 | 0.24 | 0.43 | 255.8 | 0.391E+00 | 2.45 | 187.33 | 2.45 | 0.00 | .30671E+04 |
| 211.91 | 0.24 | 0.43 | 256.5 | 0.390E+00 | 2.44 | 188.97 | 2.44 | 0.00 | .31198E+04 |
| 215.12 | 0.24 | 0.43 | 257.1 | 0.389E+00 | 2.42 | 190.60 | 2.42 | 0.00 | .31725E+04 |
| 218.34 | 0.24 | 0.43 | 257.7 | 0.388E+00 | 2.41 | 192.21 | 2.41 | 0.00 | .32252E+04 |
| 221.55 | 0.24 | 0.43 | 258.3 | 0.387E+00 | 2.39 | 193.81 | 2.39 | 0.00 | .32779E+04 |
| 224.76 | 0.24 | 0.43 | 258.9 | 0.386E+00 | 2.38 | 195.41 | 2.38 | 0.00 | .33306E+04 |
| 227.97 | 0.24 | 0.43 | 259.5 | 0.385E+00 | 2.37 | 196.99 | 2.37 | 0.00 | .33833E+04 |
| 231.19 | 0.24 | 0.43 | 260.1 | 0.384E+00 | 2.35 | 198.56 | 2.35 | 0.00 | .34360E+04 |
| 234.40 | 0.24 | 0.43 | 260.7 | 0.384E+00 | 2.34 | 200.12 | 2.34 | 0.00 | .34887E+04 |
| 237.61 | 0.24 | 0.43 | 261.3 | 0.383E+00 | 2.33 | 201.67 | 2.33 | 0.00 | .35414E+04 |
| 240.83 | 0.24 | 0.43 | 261.8 | 0.382E+00 | 2.32 | 203.21 | 2.32 | 0.00 | .35941E+04 |
| 244.04 | 0.24 | 0.43 | 262.4 | 0.381E+00 | 2.30 | 204.75 | 2.30 | 0.00 | .36468E+04 |
| 247.25 | 0.24 | 0.43 | 263.0 | 0.380E+00 | 2.29 | 206.27 | 2.29 | 0.00 | .36995E+04 |
| 250.46 | 0.24 | 0.43 | 263.5 | 0.379E+00 | 2.28 | 207.78 | 2.28 | 0.00 | .37522E+04 |
| 253.68 | 0.24 | 0.43 | 264.1 | 0.379E+00 | 2.27 | 209.29 | 2.27 | 0.00 | .38049E+04 |
| 256.89 | 0.24 | 0.43 | 264.7 | 0.378E+00 | 2.26 | 210.78 | 2.26 | 0.00 | .38576E+04 |
| 260.10 | 0.24 | 0.43 | 265.2 | 0.377E+00 | 2.24 | 212.27 | 2.24 | 0.00 | .39103E+04 |
| 263.32 | 0.24 | 0.43 | 265.8 | 0.376E+00 | 2.23 | 213.75 | 2.23 | 0.00 | .39630E+04 |
| 266.53 | 0.24 | 0.43 | 266.3 | 0.376E+00 | 2.22 | 215.22 | 2.22 | 0.00 | .40157E+04 |
| 269.74 | 0.24 | 0.43 | 266.9 | 0.375E+00 | 2.21 | 216.68 | 2.21 | 0.00 | .40684E+04 |
| 272.95 | 0.24 | 0.43 | 267.4 | 0.374E+00 | 2.20 | 218.14 | 2.20 | 0.00 | .41211E+04 |
| 276.17 | 0.24 | 0.43 | 267.9 | 0.373E+00 | 2.19 | 219.58 | 2.19 | 0.00 | .41738E+04 |
| 279.38 | 0.24 | 0.43 | 268.5 | 0.372E+00 | 2.18 | 221.02 | 2.18 | 0.00 | .42266E+04 |
| 282.59 | 0.24 | 0.43 | 269.0 | 0.372E+00 | 2.17 | 222.45 | 2.17 | 0.00 | .42793E+04 |
| 285.81 | 0.24 | 0.43 | 269.5 | 0.371E+00 | 2.16 | 223.88 | 2.16 | 0.00 | .43320E+04 |
| 289.02 | 0.24 | 0.43 | 270.0 | 0.370E+00 | 2.15 | 225.29 | 2.15 | 0.00 | .43847E+04 |
| 292.23 | 0.24 | 0.43 | 270.6 | 0.370E+00 | 2.14 | 226.70 | 2.14 | 0.00 | .44374E+04 |

| | | | | | | | | | |
|--------|------|------|-------|-----------|------|--------|------|------|------------|
| 295.44 | 0.24 | 0.43 | 271.1 | 0.369E+00 | 2.14 | 228.10 | 2.14 | 0.00 | .44901E+04 |
| 298.66 | 0.24 | 0.43 | 271.6 | 0.368E+00 | 2.13 | 229.50 | 2.13 | 0.00 | .45428E+04 |
| 301.87 | 0.24 | 0.43 | 272.1 | 0.367E+00 | 2.12 | 230.89 | 2.12 | 0.00 | .45955E+04 |
| 305.08 | 0.24 | 0.43 | 272.6 | 0.367E+00 | 2.11 | 232.27 | 2.11 | 0.00 | .46482E+04 |
| 308.30 | 0.24 | 0.43 | 273.1 | 0.366E+00 | 2.10 | 233.64 | 2.10 | 0.00 | .47009E+04 |
| 311.51 | 0.24 | 0.43 | 273.6 | 0.365E+00 | 2.09 | 235.01 | 2.09 | 0.00 | .47536E+04 |
| 314.72 | 0.24 | 0.43 | 274.1 | 0.365E+00 | 2.08 | 236.37 | 2.08 | 0.00 | .48063E+04 |
| 317.93 | 0.24 | 0.43 | 274.6 | 0.364E+00 | 2.08 | 237.73 | 2.08 | 0.00 | .48590E+04 |
| 321.15 | 0.24 | 0.43 | 275.1 | 0.363E+00 | 2.07 | 239.08 | 2.07 | 0.00 | .49117E+04 |
| 324.36 | 0.24 | 0.43 | 275.6 | 0.363E+00 | 2.06 | 240.42 | 2.06 | 0.00 | .49644E+04 |
| 327.57 | 0.24 | 0.43 | 276.1 | 0.362E+00 | 2.05 | 241.76 | 2.05 | 0.00 | .50171E+04 |
| 330.79 | 0.24 | 0.43 | 276.6 | 0.361E+00 | 2.04 | 243.09 | 2.04 | 0.00 | .50698E+04 |
| 334.00 | 0.24 | 0.43 | 277.1 | 0.361E+00 | 2.04 | 244.41 | 2.04 | 0.00 | .51225E+04 |
| 337.21 | 0.24 | 0.43 | 277.6 | 0.360E+00 | 2.03 | 245.73 | 2.03 | 0.00 | .51752E+04 |
| 340.42 | 0.24 | 0.43 | 278.1 | 0.360E+00 | 2.02 | 247.05 | 2.02 | 0.00 | .52279E+04 |
| 343.64 | 0.24 | 0.43 | 278.6 | 0.359E+00 | 2.02 | 248.35 | 2.02 | 0.00 | .52806E+04 |
| 346.85 | 0.24 | 0.43 | 279.1 | 0.358E+00 | 2.01 | 249.66 | 2.01 | 0.00 | .53333E+04 |
| 350.06 | 0.24 | 0.43 | 279.6 | 0.358E+00 | 2.00 | 250.95 | 2.00 | 0.00 | .53861E+04 |
| 353.28 | 0.24 | 0.43 | 280.1 | 0.357E+00 | 1.99 | 252.24 | 1.99 | 0.00 | .54388E+04 |
| 356.49 | 0.24 | 0.43 | 280.5 | 0.356E+00 | 1.99 | 253.53 | 1.99 | 0.00 | .54915E+04 |
| 359.70 | 0.24 | 0.43 | 281.0 | 0.356E+00 | 1.98 | 254.81 | 1.98 | 0.00 | .55442E+04 |

Cumulative travel time = 5544.1689 sec (1.54 hrs)

Plume is ATTACHED to LEFT bank/shore.

Plume width is now determined from LEFT bank/shore.

Plume Stage 2 (bank attached):

| X | Y | Z | S | C | BV | BH | ZU | ZL | TT |
|--------|--------|------|-------|-----------|------|--------|------|------|------------|
| 359.70 | 255.00 | 0.43 | 281.0 | 0.356E+00 | 1.98 | 509.53 | 1.98 | 0.00 | .55442E+04 |
| 361.10 | 255.00 | 0.43 | 281.2 | 0.356E+00 | 1.98 | 510.04 | 1.98 | 0.00 | .55672E+04 |
| 362.51 | 255.00 | 0.43 | 281.3 | 0.356E+00 | 1.98 | 510.56 | 1.98 | 0.00 | .55902E+04 |
| 363.91 | 255.00 | 0.43 | 281.4 | 0.355E+00 | 1.98 | 511.07 | 1.98 | 0.00 | .56132E+04 |
| 365.31 | 255.00 | 0.43 | 281.5 | 0.355E+00 | 1.98 | 511.58 | 1.98 | 0.00 | .56362E+04 |
| 366.72 | 255.00 | 0.43 | 281.7 | 0.355E+00 | 1.98 | 512.10 | 1.98 | 0.00 | .56592E+04 |
| 368.12 | 255.00 | 0.43 | 281.8 | 0.355E+00 | 1.98 | 512.61 | 1.98 | 0.00 | .56823E+04 |
| 369.52 | 255.00 | 0.43 | 281.9 | 0.355E+00 | 1.97 | 513.12 | 1.97 | 0.00 | .57053E+04 |
| 370.93 | 255.00 | 0.43 | 282.0 | 0.355E+00 | 1.97 | 513.63 | 1.97 | 0.00 | .57283E+04 |
| 372.33 | 255.00 | 0.43 | 282.2 | 0.354E+00 | 1.97 | 514.14 | 1.97 | 0.00 | .57513E+04 |
| 373.73 | 255.00 | 0.43 | 282.3 | 0.354E+00 | 1.97 | 514.65 | 1.97 | 0.00 | .57743E+04 |
| 375.13 | 255.00 | 0.43 | 282.4 | 0.354E+00 | 1.97 | 515.17 | 1.97 | 0.00 | .57973E+04 |
| 376.54 | 255.00 | 0.43 | 282.5 | 0.354E+00 | 1.97 | 515.68 | 1.97 | 0.00 | .58203E+04 |
| 377.94 | 255.00 | 0.43 | 282.7 | 0.354E+00 | 1.97 | 516.18 | 1.97 | 0.00 | .58434E+04 |
| 379.34 | 255.00 | 0.43 | 282.8 | 0.354E+00 | 1.97 | 516.69 | 1.97 | 0.00 | .58664E+04 |
| 380.75 | 255.00 | 0.43 | 282.9 | 0.353E+00 | 1.97 | 517.20 | 1.97 | 0.00 | .58894E+04 |
| 382.15 | 255.00 | 0.43 | 283.1 | 0.353E+00 | 1.96 | 517.71 | 1.96 | 0.00 | .59124E+04 |
| 383.55 | 255.00 | 0.43 | 283.2 | 0.353E+00 | 1.96 | 518.22 | 1.96 | 0.00 | .59354E+04 |
| 384.96 | 255.00 | 0.43 | 283.3 | 0.353E+00 | 1.96 | 518.73 | 1.96 | 0.00 | .59584E+04 |
| 386.36 | 255.00 | 0.43 | 283.4 | 0.353E+00 | 1.96 | 519.23 | 1.96 | 0.00 | .59814E+04 |
| 387.76 | 255.00 | 0.43 | 283.6 | 0.353E+00 | 1.96 | 519.74 | 1.96 | 0.00 | .60045E+04 |
| 389.16 | 255.00 | 0.43 | 283.7 | 0.353E+00 | 1.96 | 520.25 | 1.96 | 0.00 | .60275E+04 |
| 390.57 | 255.00 | 0.43 | 283.8 | 0.352E+00 | 1.96 | 520.75 | 1.96 | 0.00 | .60505E+04 |
| 391.97 | 255.00 | 0.43 | 283.9 | 0.352E+00 | 1.96 | 521.26 | 1.96 | 0.00 | .60735E+04 |
| 393.37 | 255.00 | 0.43 | 284.1 | 0.352E+00 | 1.96 | 521.77 | 1.96 | 0.00 | .60965E+04 |
| 394.78 | 255.00 | 0.43 | 284.2 | 0.352E+00 | 1.96 | 522.27 | 1.96 | 0.00 | .61195E+04 |
| 396.18 | 255.00 | 0.43 | 284.3 | 0.352E+00 | 1.95 | 522.77 | 1.95 | 0.00 | .61425E+04 |
| 397.58 | 255.00 | 0.43 | 284.4 | 0.352E+00 | 1.95 | 523.28 | 1.95 | 0.00 | .61656E+04 |
| 398.98 | 255.00 | 0.43 | 284.6 | 0.351E+00 | 1.95 | 523.78 | 1.95 | 0.00 | .61886E+04 |
| 400.39 | 255.00 | 0.43 | 284.7 | 0.351E+00 | 1.95 | 524.29 | 1.95 | 0.00 | .62116E+04 |
| 401.79 | 255.00 | 0.43 | 284.8 | 0.351E+00 | 1.95 | 524.79 | 1.95 | 0.00 | .62346E+04 |
| 403.19 | 255.00 | 0.43 | 284.9 | 0.351E+00 | 1.95 | 525.29 | 1.95 | 0.00 | .62576E+04 |
| 404.60 | 255.00 | 0.43 | 285.1 | 0.351E+00 | 1.95 | 525.79 | 1.95 | 0.00 | .62806E+04 |
| 406.00 | 255.00 | 0.43 | 285.2 | 0.351E+00 | 1.95 | 526.30 | 1.95 | 0.00 | .63037E+04 |
| 407.40 | 255.00 | 0.43 | 285.3 | 0.350E+00 | 1.95 | 526.80 | 1.95 | 0.00 | .63267E+04 |
| 408.81 | 255.00 | 0.43 | 285.5 | 0.350E+00 | 1.95 | 527.30 | 1.95 | 0.00 | .63497E+04 |
| 410.21 | 255.00 | 0.43 | 285.6 | 0.350E+00 | 1.94 | 527.80 | 1.94 | 0.00 | .63727E+04 |
| 411.61 | 255.00 | 0.43 | 285.7 | 0.350E+00 | 1.94 | 528.30 | 1.94 | 0.00 | .63957E+04 |
| 413.01 | 255.00 | 0.43 | 285.8 | 0.350E+00 | 1.94 | 528.80 | 1.94 | 0.00 | .64187E+04 |

| | | | | | | | | | |
|--------|--------|------|-------|-----------|------|--------|------|------|------------|
| 414.42 | 255.00 | 0.43 | 286.0 | 0.350E+00 | 1.94 | 529.30 | 1.94 | 0.00 | .64417E+04 |
| 415.82 | 255.00 | 0.43 | 286.1 | 0.350E+00 | 1.94 | 529.80 | 1.94 | 0.00 | .64648E+04 |
| 417.22 | 255.00 | 0.43 | 286.2 | 0.349E+00 | 1.94 | 530.30 | 1.94 | 0.00 | .64878E+04 |
| 418.63 | 255.00 | 0.43 | 286.3 | 0.349E+00 | 1.94 | 530.80 | 1.94 | 0.00 | .65108E+04 |
| 420.03 | 255.00 | 0.43 | 286.5 | 0.349E+00 | 1.94 | 531.30 | 1.94 | 0.00 | .65338E+04 |
| 421.43 | 255.00 | 0.43 | 286.6 | 0.349E+00 | 1.94 | 531.79 | 1.94 | 0.00 | .65568E+04 |
| 422.84 | 255.00 | 0.43 | 286.7 | 0.349E+00 | 1.94 | 532.29 | 1.94 | 0.00 | .65798E+04 |
| 424.24 | 255.00 | 0.43 | 286.8 | 0.349E+00 | 1.93 | 532.79 | 1.93 | 0.00 | .66028E+04 |
| 425.64 | 255.00 | 0.43 | 287.0 | 0.348E+00 | 1.93 | 533.29 | 1.93 | 0.00 | .66259E+04 |
| 427.04 | 255.00 | 0.43 | 287.1 | 0.348E+00 | 1.93 | 533.78 | 1.93 | 0.00 | .66489E+04 |
| 428.45 | 255.00 | 0.43 | 287.2 | 0.348E+00 | 1.93 | 534.28 | 1.93 | 0.00 | .66719E+04 |
| 429.85 | 255.00 | 0.43 | 287.4 | 0.348E+00 | 1.93 | 534.77 | 1.93 | 0.00 | .66949E+04 |
| 431.25 | 255.00 | 0.43 | 287.5 | 0.348E+00 | 1.93 | 535.27 | 1.93 | 0.00 | .67179E+04 |
| 432.66 | 255.00 | 0.43 | 287.6 | 0.348E+00 | 1.93 | 535.76 | 1.93 | 0.00 | .67409E+04 |
| 434.06 | 255.00 | 0.43 | 287.7 | 0.348E+00 | 1.93 | 536.26 | 1.93 | 0.00 | .67640E+04 |
| 435.46 | 255.00 | 0.43 | 287.9 | 0.347E+00 | 1.93 | 536.75 | 1.93 | 0.00 | .67870E+04 |
| 436.87 | 255.00 | 0.43 | 288.0 | 0.347E+00 | 1.93 | 537.25 | 1.93 | 0.00 | .68100E+04 |
| 438.27 | 255.00 | 0.43 | 288.1 | 0.347E+00 | 1.93 | 537.74 | 1.93 | 0.00 | .68330E+04 |
| 439.67 | 255.00 | 0.43 | 288.2 | 0.347E+00 | 1.92 | 538.24 | 1.92 | 0.00 | .68560E+04 |
| 441.07 | 255.00 | 0.43 | 288.4 | 0.347E+00 | 1.92 | 538.73 | 1.92 | 0.00 | .68790E+04 |
| 442.48 | 255.00 | 0.43 | 288.5 | 0.347E+00 | 1.92 | 539.22 | 1.92 | 0.00 | .69020E+04 |
| 443.88 | 255.00 | 0.43 | 288.6 | 0.346E+00 | 1.92 | 539.71 | 1.92 | 0.00 | .69251E+04 |
| 445.28 | 255.00 | 0.43 | 288.8 | 0.346E+00 | 1.92 | 540.21 | 1.92 | 0.00 | .69481E+04 |
| 446.69 | 255.00 | 0.43 | 288.9 | 0.346E+00 | 1.92 | 540.70 | 1.92 | 0.00 | .69711E+04 |
| 448.09 | 255.00 | 0.43 | 289.0 | 0.346E+00 | 1.92 | 541.19 | 1.92 | 0.00 | .69941E+04 |
| 449.49 | 255.00 | 0.43 | 289.1 | 0.346E+00 | 1.92 | 541.68 | 1.92 | 0.00 | .70171E+04 |
| 450.90 | 255.00 | 0.43 | 289.3 | 0.346E+00 | 1.92 | 542.17 | 1.92 | 0.00 | .70401E+04 |
| 452.30 | 255.00 | 0.43 | 289.4 | 0.346E+00 | 1.92 | 542.66 | 1.92 | 0.00 | .70631E+04 |
| 453.70 | 255.00 | 0.43 | 289.5 | 0.345E+00 | 1.92 | 543.15 | 1.92 | 0.00 | .70862E+04 |
| 455.10 | 255.00 | 0.43 | 289.7 | 0.345E+00 | 1.91 | 543.64 | 1.91 | 0.00 | .71092E+04 |
| 456.51 | 255.00 | 0.43 | 289.8 | 0.345E+00 | 1.91 | 544.13 | 1.91 | 0.00 | .71322E+04 |
| 457.91 | 255.00 | 0.43 | 289.9 | 0.345E+00 | 1.91 | 544.62 | 1.91 | 0.00 | .71552E+04 |
| 459.31 | 255.00 | 0.43 | 290.0 | 0.345E+00 | 1.91 | 545.11 | 1.91 | 0.00 | .71782E+04 |
| 460.72 | 255.00 | 0.43 | 290.2 | 0.345E+00 | 1.91 | 545.60 | 1.91 | 0.00 | .72012E+04 |
| 462.12 | 255.00 | 0.43 | 290.3 | 0.344E+00 | 1.91 | 546.08 | 1.91 | 0.00 | .72242E+04 |
| 463.52 | 255.00 | 0.43 | 290.4 | 0.344E+00 | 1.91 | 546.57 | 1.91 | 0.00 | .72473E+04 |
| 464.93 | 255.00 | 0.43 | 290.5 | 0.344E+00 | 1.91 | 547.06 | 1.91 | 0.00 | .72703E+04 |
| 466.33 | 255.00 | 0.43 | 290.7 | 0.344E+00 | 1.91 | 547.55 | 1.91 | 0.00 | .72933E+04 |
| 467.73 | 255.00 | 0.43 | 290.8 | 0.344E+00 | 1.91 | 548.03 | 1.91 | 0.00 | .73163E+04 |
| 469.13 | 255.00 | 0.43 | 290.9 | 0.344E+00 | 1.91 | 548.52 | 1.91 | 0.00 | .73393E+04 |
| 470.54 | 255.00 | 0.43 | 291.1 | 0.344E+00 | 1.90 | 549.01 | 1.90 | 0.00 | .73623E+04 |
| 471.94 | 255.00 | 0.43 | 291.2 | 0.343E+00 | 1.90 | 549.49 | 1.90 | 0.00 | .73854E+04 |
| 473.34 | 255.00 | 0.43 | 291.3 | 0.343E+00 | 1.90 | 549.98 | 1.90 | 0.00 | .74084E+04 |
| 474.75 | 255.00 | 0.43 | 291.4 | 0.343E+00 | 1.90 | 550.46 | 1.90 | 0.00 | .74314E+04 |
| 476.15 | 255.00 | 0.43 | 291.6 | 0.343E+00 | 1.90 | 550.95 | 1.90 | 0.00 | .74544E+04 |
| 477.55 | 255.00 | 0.43 | 291.7 | 0.343E+00 | 1.90 | 551.43 | 1.90 | 0.00 | .74774E+04 |
| 478.96 | 255.00 | 0.43 | 291.8 | 0.343E+00 | 1.90 | 551.92 | 1.90 | 0.00 | .75004E+04 |
| 480.36 | 255.00 | 0.43 | 292.0 | 0.343E+00 | 1.90 | 552.40 | 1.90 | 0.00 | .75234E+04 |
| 481.76 | 255.00 | 0.43 | 292.1 | 0.342E+00 | 1.90 | 552.88 | 1.90 | 0.00 | .75465E+04 |
| 483.16 | 255.00 | 0.43 | 292.2 | 0.342E+00 | 1.90 | 553.37 | 1.90 | 0.00 | .75695E+04 |
| 484.57 | 255.00 | 0.43 | 292.3 | 0.342E+00 | 1.90 | 553.85 | 1.90 | 0.00 | .75925E+04 |
| 485.97 | 255.00 | 0.43 | 292.5 | 0.342E+00 | 1.90 | 554.33 | 1.90 | 0.00 | .76155E+04 |
| 487.37 | 255.00 | 0.43 | 292.6 | 0.342E+00 | 1.89 | 554.81 | 1.89 | 0.00 | .76385E+04 |
| 488.78 | 255.00 | 0.43 | 292.7 | 0.342E+00 | 1.89 | 555.30 | 1.89 | 0.00 | .76615E+04 |
| 490.18 | 255.00 | 0.43 | 292.9 | 0.341E+00 | 1.89 | 555.78 | 1.89 | 0.00 | .76845E+04 |
| 491.58 | 255.00 | 0.43 | 293.0 | 0.341E+00 | 1.89 | 556.26 | 1.89 | 0.00 | .77076E+04 |
| 492.98 | 255.00 | 0.43 | 293.1 | 0.341E+00 | 1.89 | 556.74 | 1.89 | 0.00 | .77306E+04 |
| 494.39 | 255.00 | 0.43 | 293.2 | 0.341E+00 | 1.89 | 557.22 | 1.89 | 0.00 | .77536E+04 |
| 495.79 | 255.00 | 0.43 | 293.4 | 0.341E+00 | 1.89 | 557.70 | 1.89 | 0.00 | .77766E+04 |
| 497.19 | 255.00 | 0.43 | 293.5 | 0.341E+00 | 1.89 | 558.18 | 1.89 | 0.00 | .77996E+04 |
| 498.60 | 255.00 | 0.43 | 293.6 | 0.341E+00 | 1.89 | 558.66 | 1.89 | 0.00 | .78226E+04 |
| 500.00 | 255.00 | 0.43 | 293.8 | 0.340E+00 | 1.89 | 559.14 | 1.89 | 0.00 | .78456E+04 |

Cumulative travel time = 7845.6514 sec (2.18 hrs)

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Simulation limit based on maximum specified distance = 500.00 m.

This is the REGION OF INTEREST limitation.

END OF MOD242: BUOYANT TERMINAL LAYER SPREADING

A large, light blue graphic element consisting of the letters "DRCI" in a bold, sans-serif font. The letters are slightly slanted upwards from left to right. The letter "D" is a simple semi-circle. The letter "R" has a vertical stroke on its right side. The letter "C" is a circle with a horizontal cutout on its right side. The letter "I" is a single vertical line.

Appendix D: CORMIX Session Report for Uniform Ambient Density

CORMIX SESSION REPORT:

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XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
CORMIX MIXING ZONE EXPERT SYSTEM
CORMIX Version 9.0GTD
HYDRO2:Version-9.0.0.0 September, 2014
SITE NAME/LABEL: Pend Oreille River - Sandpoint outfall
DESIGN CASE: Sandpoint WWTP TP discharge to Pend Oreille River
FILE NAME: F:\My Folder\!Permits!\Sandpoint\CORMIX
Modeling\Using 2005 DEQ T Data\Unbounded\Sandpoint Measured Low Velocity 5 mgd
density gradient unbounded counterflow actual angle.prd
Using subsystem CORMIX2: Multiport Diffuser Discharges
Start of session: 09/09/2015--12:24:20
*****
SUMMARY OF INPUT DATA:
-----
AMBIENT PARAMETERS:
Cross-section = unbounded
Average depth HA = 6.71 m
Depth at discharge HD = 5.18 m
Ambient velocity UA = 0.0610 m/s
Darcy-Weisbach friction factor F = 0.0167
Calculated from Manning's n = 0.02
Wind velocity UW = 3.58 m/s
Stratification Type STRCND = A
Surface temperature = 21.30 degC
Bottom temperature = 20.5 degC
Calculated FRESH-WATER DENSITY values:
Surface density RHOAS = 997.9279 kg/m^3
Bottom density RHOAB = 998.1006 kg/m^3
-----
DISCHARGE PARAMETERS:
Submerged Multiport Diffuser Discharge
Diffuser type DITYPE = unidirectional perpendicular
Diffuser length LD = 49.99 m
Nearest bank = left
Diffuser endpoints YB1 = 234.28 m; YB2 = 275.72 m
Number of openings NOOPEN = 41
Number of Risers NRISER = 41
Ports/Nozzles per Riser NPPERR = 1
Spacing between risers/openings SPAC = 1.25 m
Port/Nozzle diameter D0 = 0.0762 m
with contraction ratio = 1
Equivalent slot width B0 = 0.0037 m
Total area of openings TAO = 0.1870 m^2
Discharge velocity U0 = 1.17 m/s
Total discharge flowrate Q0 = 0.219063 m^3/s
Discharge port height H0 = 0.41 m
Nozzle arrangement BETYPE = unidirectional without fanning
Diffuser alignment angle GAMMA = 56 deg
Vertical discharge angle THETA = 0 deg
Actual Vertical discharge angle THEAC = 0 deg
Horizontal discharge angle SIGMA = 146 deg
Relative orientation angle BETA = 90 deg
Discharge temperature (freshwater) = 21 degC
```

Corresponding density RHO0 = 997.9934 kg/m³
Density difference DRHO = 0.0936 kg/m³
Buoyant acceleration GP0 = 0.0009 m/s²
Discharge concentration C0 = 100 %
Surface heat exchange coeff. KS = 0 m/s
Coefficient of decay KD = 0 /s

FLUX VARIABLES PER UNIT DIFFUSER LENGTH:

Discharge (volume flux) q0 = 0.004382 m²/s
Momentum flux m0 = 0.005134 m³/s²
Buoyancy flux j0 = 0.000004 m³/s³

DISCHARGE/ENVIRONMENT LENGTH SCALES:

LQ = 0.00 m Lm = 1.38 m LM = 20.21 m

lm' = 2.50 m Lb' = 0.88 m La = 3.37 m

(These refer to the actual discharge/environment length scales.)

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NON-DIMENSIONAL PARAMETERS:

Slot Froude number FR0 = 631.57
Port/nozzle Froude number FRD0 = 139.93
Velocity ratio R = 19.22

MIXING ZONE / TOXIC DILUTION ZONE / AREA OF INTEREST PARAMETERS:

Toxic discharge = no
Water quality standard specified = no
Regulatory mixing zone = no
Region of interest = 500 m downstream

HYDRODYNAMIC CLASSIFICATION:

| FLOW CLASS = MS1 |

This flow configuration applies to a layer corresponding to the linearly stratified density layer at the discharge site.

Applicable layer depth = water depth = 5.18 m

MIXING ZONE EVALUATION (hydrodynamic and regulatory summary):

X-Y-Z Coordinate system:

Origin is located at the BOTTOM below the port/diffuser center:
255 m from the left bank/shore.

Number of display steps NSTEP = 100 per module.

NEAR-FIELD REGION (NFR) CONDITIONS :

Note: The NFR is the zone of strong initial mixing. It has no regulatory implication. However, this information may be useful for the discharge designer because the mixing in the NFR is usually sensitive to the discharge design conditions.

Pollutant concentration at NFR edge c = 0.5073 %

Dilution at edge of NFR s = 197.1

NFR Location: x = 38.42 m

(centerline coordinates) y = 0.24 m

z = 0.43 m

NFR plume dimensions: half-width (bh) = 68.35 m
thickness (bv) = 5.18 m
Cumulative travel time: 273.7231 sec.

Buoyancy assessment:

The effluent density is less than the surrounding ambient water density at the discharge level.
Therefore, the effluent is POSITIVELY BUOYANT and will tend to rise towards the surface.

Stratification assessment:

The specified ambient density stratification is dynamically important.
The discharge near field flow is trapped within the linearly stratified ambient density layer.

FAR-FIELD MIXING SUMMARY:

Plume becomes vertically fully mixed WITHIN NEAR-FIELD at 0 m downstream, but RE-STRATIFIES LATER and is not mixed in the far-field.

PLUME BANK CONTACT SUMMARY:

Plume in unbounded section contacts nearest bank at 359.70 m downstream.
***** TOXIC DILUTION ZONE SUMMARY *****
No TDZ was specified for this simulation.
***** REGULATORY MIXING ZONE SUMMARY *****
No RMZ and no ambient water quality standard have been specified.
***** FINAL DESIGN ADVICE AND COMMENTS *****
The diffuser ports or nozzles point towards the nearest bank.
Since this is an UNUSUAL DESIGN, check whether you have specified correctly the port/nozzle geometry (angles GAMMA, SIGMA and BETA).

CORMIX2 uses the TWO-DIMENSIONAL SLOT DIFFUSER CONCEPT to represent the actual three-dimensional diffuser geometry. Thus, it approximates the details of the merging process of the individual jets from each port/nozzle.

In the present design, the spacing between adjacent ports/nozzles (or riser assemblies) is of the order of, or less than, the local water depth so that the slot diffuser approximation holds well.

Nevertheless, if this is a final design, the user is advised to use a final CORMIX1 (single port discharge) analysis, with discharge data for an individual diffuser jet/plume, in order to compare to the present near-field prediction.

REMINDER: The user must take note that HYDRODYNAMIC MODELING by any known technique is NOT AN EXACT SCIENCE.

Extensive comparison with field and laboratory data has shown that the CORMIX predictions on dilutions and concentrations (with associated plume geometries) are reliable for the majority of cases and are accurate to within about +/- 50% (standard deviation).

As a further safeguard, CORMIX will not give predictions whenever it judges the design configuration as highly complex and uncertain for prediction.